Appendix H

Electromagnetic Interference Assessment (Telecommunications) (Aitken & Partners)

Flyers Creek Wind Farm Pty Ltd

Flyers Creek Wind Farm

Electromagnetic Interference Assessment

Aitken & Partners
Consulting Engineers

PO Box 933, Hornsby, NSW Australia
Ph +612 9489 7607 • ACN 002 655 585
jja.com.au

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Introduction

1. INTRODUCTION

1.1 BACKGROUND

This electromagnetic interference assessment was commissioned by Flyers Creek Wind Farm Pty Ltd to accompany the Planning Modification 4 application and was performed by John Aitken, a director of Aitken & Partners.

The assessment updates a previous assessment performed by Lawrence Derrick & Associates for the Flyers Creek Wind Farm project on 22 December 2010 [1]. The Lawrence Derrick & Associates report was based on the original layout of up to 44 turbines, whereas the current approved layout has 38 turbines, an overall reduction of 6 turbines.

Modification 4 includes changes to the maximum turbine envelope and inclusion of a 132kVtransmission line and switching station. The location of the turbines in Modification 4 is unchanged from the approved locations.

The changes to the maximum turbine envelope are listed in the table below.

Turbine Component (m)	Approved Turbine	Proposed Turbine
Tip Height	Up to 150 m	Up to 160 m
Rotor Diameter	Up to 112 m	Up to 140 m
Blade Length	Up to 56 m	Up to 70 m
Hub Height	80 m to 100 m	90 m to 92 m

Table 1-1 Changes to the maximum turbine envelope

1.2 LEGISLATIVE REQUIREMENTS

1.2.1 Radiocommunications Legislation

The Radiocommunications Act 1992 is the overarching legislation that deals with management of the radio frequency spectrum. The effects of radio frequency energy on people are managed under the *Radiocommunications (Electromagnetic Radiation — Human Exposure) Standard 2014* and the electromagnetic compatibility of equipment is managed under the *Radiocommunications (Electromagnetic Compatibility) Standard 2008*. Both these standards were made under subsection 162 (1) of the Radiocommunications Act.

The Australian Media and Communications Authority (ACMA) is the organisation responsible for implementation and management of the radio communications legislation.

The ACMA manages radio frequency spectrum usage through a licensing scheme and a spectrum allocation plan that ensures that each allocation of spectrum can be used for its assigned purpose, without intolerable interference from other uses.

Broadcasting

A part of the radio frequency spectrum is assigned for radio and television broadcasting. The allocation of this spectrum is designed to ensure adequate coverage of defined areas for radio and for television broadcasts. There is no guarantee or mandate for 100% coverage of any area and the coverage definitions are based on achieving coverage of a certain percentage of any area for a certain percentage of the time. The broadcasting and television plans make assumptions about the quality and performance of the antenna systems and receivers that will be used by the public.

Over recent years the ACMA has planned and managed the transition from analogue to digital television throughout Australia. This process has included re-planning of the allocation of television channels and the polarisation of television signals to optimise the use of allocated spectrum. The replanning process has mostly occurred since the 2012 report.

Fixed Links

Microwave dishes on radio communication towers and buildings are a familiar sight. These dishes are one of the forms of "fixed links" or "point to point" communication systems. The links usually transmit in both directions between two defined sites. The performance of these links is critical to their users and the ACMA spectrum management process has special provisions to ensure that the links can operate without unacceptable interference. The planning process for these links includes assessment of other links in the area and the extent to which they will interfere with the planned link and vice versa.

Another category of fixed link is "point to multipoint". In this type of link there is a master location that communicates with a number of other locations; for example, a number of water monitoring sites. The link to each point is managed in the same manner as an individual fixed link.

Mobile Radio and Cellular

Mobile radio and cellular telephone systems have defined base station locations and then defined areas of coverage. The performance of the communication systems within their coverage areas is defined statistically, in a similar manner to that of broadcast systems. There is no guarantee of coverage at any particular location but there is a guarantee that there will not be intolerable interference from other sources at any location within the coverage area.

Emissions from Turbines and Power Lines

The radio communications legislation limits the electromagnetic radiation from wind farm turbines, along with every other electric component of a wind farm. The emissions are limited by the Radiocommunications (Electromagnetic Compatibility) Standard.

Interference

It is important to recognise that the radio communications legislation only considers electromagnetic energy. It does not consider the physical shape or location of devices that could interfere with radio communication. For example, a building that blocks the path of a microwave link is not covered by the radio communications legislation. Neither are reflections or obstruction of paths by wind turbines.

In the Radiocommunications Act 1992 interference means:

> *(a) in relation to radiocommunications—interference to, or with, radiocommunications that is attributable, whether wholly or partly and whether directly or indirectly, to an emission of electromagnetic energy by a device; or*

(b) in relation to the uses or functions of devices—interference to, or with, those uses or functions that is attributable, whether wholly or partly and whether directly or indirectly, to an emission of electromagnetic energy by a device.

Compliance with these requirements is dealt with through the electromagnetic compatibility processes; identified by compliance certification from the manufacturer of the device.

1.2.2 Project Approval

Project Approval for Flyers Creek Wind Farm under Section 75J of the Environmental Planning & Assessment Act 1979, was given on 14 March 2014. The Project Approval includes conditions relating to electromagnetic interference:

D9. Any overhead transmission line associated with the Project shall be designed, constructed and operated to minimise the generation of corona and aeolian noise as far as feasible and reasonable at nearest existing sensitive receivers.

D14. Prior to the commencement of construction, the Proponent shall:

- *(a) consult with the NSW Government Telecommunications Authority and other registered communications licensees (including emergency services) to ensure that risks to these services are minimised as far as feasible and reasonable. This may include the installation of additional radio sites or services to ensure coverage of radio communications are not degraded;*
- *(b) in the event that any disruptions to radio communication service links (installed before construction of the Project) arise as a result of the Project, the Proponent shall undertake appropriate remedial measures in consultation with the NSW Government Telecommunications Authority and relevant licensee to rectify any issue, including arranging the deployment of temporary measures in order to maintain effective coverage whilst more permanent measures are effected, within three months of the problem being identified, and at the expense of the Proponent;*
- *(c) consider remedial measures, including:*
  - *i. modification to or relocation of the existing antennae;*
  - *ii. installation and maintenance of additional radio sites or services;*
  - *iii. installation of a directional antennae; and / or*
  - *iv. installation of an amplifier to boost the signal strength.*

G3. Prior to the commencement of commissioning of the Project, the Proponent shall undertake an assessment of the existing quality of the television, radio and telephone/internet transmission available at a representative sample of receivers located within five kilometres of any wind turbine.

G4. In the event of a complaint from a receptor located within five kilometres of a wind turbine regarding television / radio / telephone / internet transmission during the operation of the Project, the Proponent shall investigate the quality of transmission at the receptor compared with the pre-commissioning assessment and where any transmission problems can be reasonably attributable to the Project, rectify the problems as soon as possible and within three months of the receipt of the complaint, through the implementation of measures including:

- *(d) modification to or replacement of receiving antenna;*
- *(e) installation and maintenance of a parasitic antenna system;*

(f) *provision of a land line between the affected receptor and an antenna located in an area of favourable reception; and / or*

(g) *other feasible measures.*

If interference cannot be overcome by the measures outlined in (a) to (d), the Proponent shall negotiate with the impacted landowner(s) about installing and maintaining a satellite receiving antenna. The Proponent shall be responsible for all costs associated with any such mitigation measures.

1.3 CLEAN ENERGY COUNCIL BEST PRACTICE GUIDELINES

The Clean Energy Council has issued Best Practice Guidelines [2] for implementation of wind energy projects in Australia. These guidelines, originally issued in 2006, were updated in the 2013 version. The Best Practice Guidelines discuss electromagnetic interference in Appendix 9. They note that wind farms may affect telecommunications systems through the following mechanisms:

- *the wind turbine tower may obstruct, reflect or refract the electromagnetic waves used in a range of communications systems for transmission*
- *the rotating blades may have similar effects, on a time- variable basis. In some cases ghosting of TV receivers close to the wind farm may occur where metal blades (or those with metallic cores or metal components such as the lightning protection system) act as an aerial to on-transmit the communication signal*
- *the wind turbine's electrical generator can produce electromagnetic interference, which may need to be suppressed by shielding design and maintenance of wind turbines (although in practice, a generator is little different from a typical electrical motor and it is quite rare for a wind turbine generator to present such a problem).*

The Guidelines suggest the following criteria for assessment:

- *a wind turbine is within 2 km of a radiocommunications transmission site; or within 2 km of a radiocommunications receiver and in line with the transmission site*
- *a wind turbine is within the maximum second Fresnel zone of a point to point radio link.*

These Guidelines further refer to the *Technical Information and Coordination Process Between Wind Turbines and Radiocommunication and Radar Systems*, published by the Radio Advisory Board of Canada (RABC) & Canadian Wind Energy Association (CanWEA), 2007 [3]. The provisions of the Canadian Guidelines are discussed later in this report.

1.4 CONSULTANT'S EXPERIENCE

JJ Aitken & Partners Pty Ltd (trading as Aitken & Partners) commenced operations in 1983, practicing in radio communications consultancy. Aitken & Partners currently practices in the areas of communications, broadcasting and electromagnetic compatibility engineering.

Aitken & Partners has been active in television coverage design and implementation, radio broadcasting systems and link design. We designed the transmission and

rebroadcast system for MVQ6 in Mackay (Queensland), adding a large geographic area and many mining towns to their coverage footprint.

The National Transmission Agency, which was then responsible for ABC and SBS television and radio transmitters throughout Australia, commissioned Aitken & Partners (as part of a multi-discipline team) to perform audits and then supervise upgrades of over twenty AM radio, FM radio and television sites around Australia. The work included coverage tests for many of the transmitters before and after the upgrading.

Aitken & Partners has performed pre-construction television and radio surveys for wind farms at Bodangora, Crookwell 2, Mt Gellibrand, Gunning, Woodlawn, Mortlake South, Gullen Range, Newfield, Tarago and Cherry Tree.

Interference Mechanisms

2. INTERFERENCE MECHANISMS

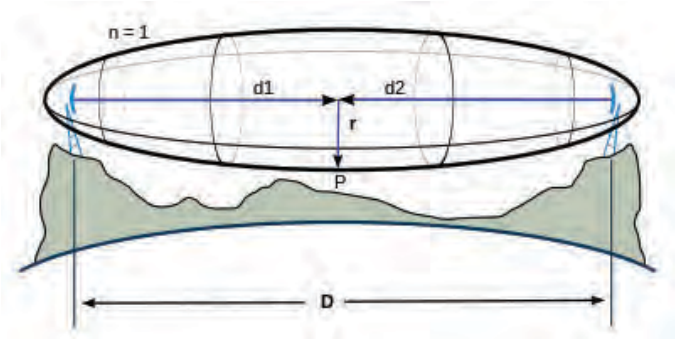
2.1 OVERVIEW

There are many possible interactions between wind turbines and communication systems, however, the most significant interference mechanisms can be summarised in a few categories. The discussion in the following section is derived in part from the Canadian technical information [3] and uses some diagrams from [3].

2.2 PATH OBSTRUCTION

High performance radio communication systems, such as microwave links, require a direct "line of sight" between the transmitting and receiving antennas. However, not only is a direct line of sight required, but there must be an unobstructed area around the line of sight, usually defined as some number of *Fresnel Zones*. The Fresnel zone is a spheroid that on which any reflected wave is either in phase with the direct signal (odd numbered Fresnel Zones) or out of phase with the direct signal (even numbered Fresnel Zones). Wave paths that are in phase with the direct signal add to the direct signal, enhancing it, while those that are out of phase with the direct signal cancel some part of the direct signal.

For microwave link design it is standard practice to ensure that at least 0.6 of the First Fresnel zone is clear of obstructions.



In Figure 2-1 D is the distance between the transmitter and receiver; r is the radius of the first Fresnel zone (n=1) at point P. P is d1 away from the transmitter and d2 away from the receiver.

Figure 2-1 Fresnel Zone (Wikipedia)

The Fresnel zone radius for a wavelength λ is defined as $F_n = \sqrt{\frac{n\,\lambda\,d_1\,d_2}{d_1 + d_2}}$.

For 0.6 of the first Fresnel zone, the required clearance in metres is

$$F_{1\,(0.6)} = 10.38\sqrt{\frac{d_1\,d_2}{Frequency\ x\ D}}$$

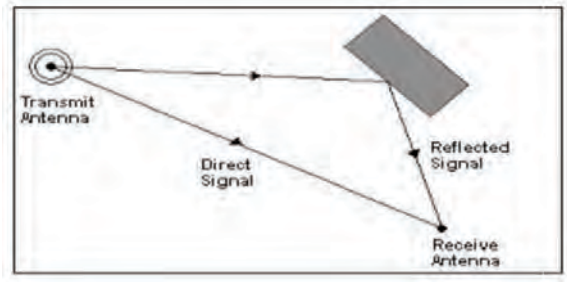
where the frequency is in MHz and the distances D, d_1 and d_2 are in metres.

2.3 SHADOWING

Large obstacles, such as buildings, hills or wind farms can create shadowed areas where the line of sight from the transmitter to the receiver is blocked. The size of the shadowed area depends on the location and height of the obstacle. The effect of the

obstacle depends on its shape and position, with large rounded obstacles causing more loss of signal than pointed or “wedge” shaped obstacles. Any obstacle that intrudes into the area beyond 0.6 of the first Fresnel zone will reduced the signal at the receiver, with greater reduction in signal as a greater portion of the path is blocked.

2.4 MIRROR-LIKE REFLECTIONS

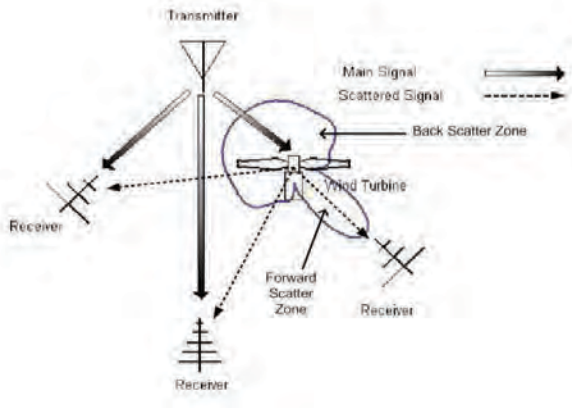


Mirror-like (specular) reflections are caused when the signal from the transmitter is reflected from a surface before reaching the receiving antenna. The reflected signal travels further than the direct signal and therefore arrives at the receiver later than the direct signal.

The reflected signal can degrade the direct signal, either due to cancellation due to the difference in path length, or to interference due to delayed signals having different modulation information from the direct signal.

Digital transmission techniques are designed to reject or compensate for some reflected signals. Delayed signals were most evident as “ghosting” on analogue television images.

2.5 SCATTERING



When a radio signal reaches a wind turbine, the support tower and the rotating blades of the turbine can produce a pulsed scattering of the signal, synchronised with the rotational speed of the blades. These scattered pulses include a Doppler component, which produces variations in the resulting signal phase and amplitude reaching a receiver. This scattering occurs all around the wind turbine but presents different characteristics in the forward scatter and back scatter zones.

In the forward scatter zone, a relatively narrow sector beyond the turbine, the effect on the transmitted signal is analogous to shadowing, with the signal varying in amplitude and phase in synchronism with the rotation of the turbine blades.

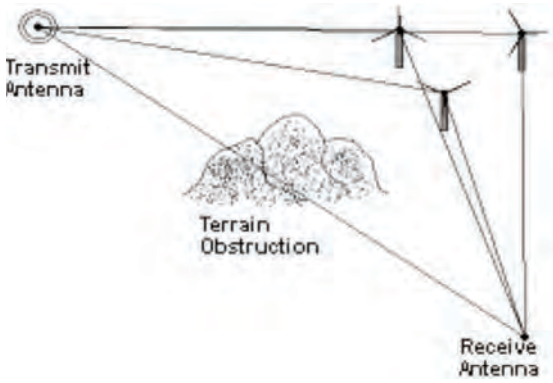
In the back scatter zone, a wider sector between the turbine and the transmitter, the effect is similar to a mirror reflection. However, here too, the scattered signal contains both phase and amplitude variations when the wind turbine is operating.

2.6 MF RE-RADIATION

If the turbine support structures are sufficiently tall and are close to medium frequency (MF) (usually AM radio) broadcasting stations, the structures can re-radiate the radio

signal. This must be taken into account if a wind farm is located close to an MF radio transmitting site, particularly if the site uses a directional antenna system.

2.7 TERRAIN OBSTRUCTIONS



The impact of a turbine on a radio signal can be more severe if the direct path between the transmitter and receiver is partially obstructed by terrain, while the reflected path from the turbine is not obstructed. In this situation the wanted (direct) signal can be similar to or lower than the unwanted (reflected) signal from the turbine. The detrimental effects of turbine operation are then more pronounced.

Broadcasting

3. BROADCASTING

3.1 RADIO AND TELEVISION SERVICE AREAS

The Australian Communications and Media Authority defines the licence areas and service areas for broadcast and television services. The defined areas are those in which the transmission from a licensed station must achieve a certain level and in which their transmissions will be protected from interference.

It is often the case that transmissions from stations outside the service area of a station will be heard clearly in another service area. This is considered fortuitous reception. FM radio and television reception from distant stations may be available in locations where the terrain favours transmission, such as high areas, which often have reception from a number of FM radio stations and television stations that are not in the defined service area. This reception is not guaranteed and is not protected from interference.

The coverage information and coverage predictions provided by the ACMA have been used in this report, in conjunction with field surveys.

3.2 MF AM RADIO

3.2.1 Overview

Medium Frequency (MF) AM radio stations generally have large coverage areas and transmission at these frequencies is unaffected by wind farm turbines. The turbine structures can cause distortion of antenna radiation patterns if the structures are close to the AM transmitter. There is also a potential hazard from induced current on cranes and other structures if the construction is very close to a radio transmitting site.

The MF radio stations in the area surrounding the wind farm are shown in Figure 3-1.

Figure 3-1 AM Broadcasting Sites

The closest AM radio station is the Orange commercial broadcaster on 1809 kHz at 43 Gartholme Lane, Forest Reefs.

There is also a narrowband area service on 1620 kHz at Waverleigh Park, Blayney. The Blayney service is at low power (400 W) and is intended to have only local coverage.

The closest transmitter is the 1089 kHz service, which is more than 6 km from the nearest turbine (Turbine 3). There is adequate separation between this radio transmitter and the wind farm.

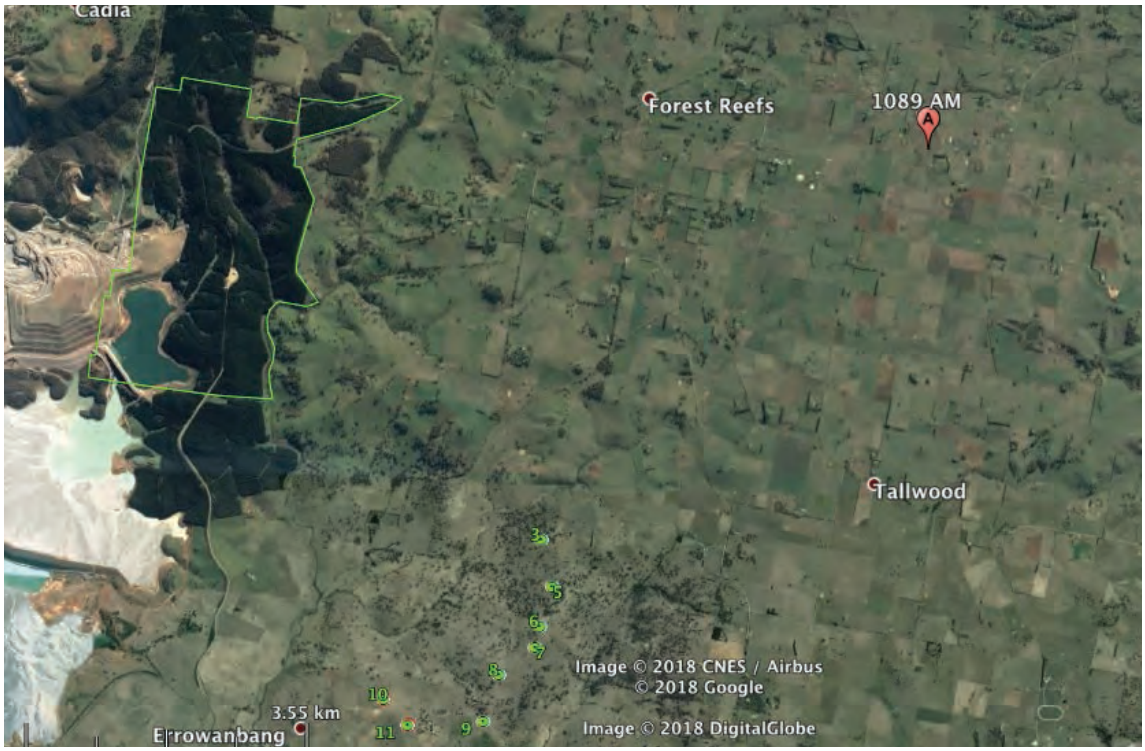


Figure 3-2 1089 kHz AM Radio transmitter location

The AM radio stations defined in the Central Tablelands Licence Area Plan for Radio are listed below. The power shown in the table is the effective isotropic radiated power (EIRP).

Call Sign	Licence	Area Served	Frequency	Power
2CR	National	Cumnock	549 kHz	153 kW
2EL	Commercial	Orange	1089 kHz	22 kW

Table 3-1 AM Radio stations licenced for Central Tablelands area

3.2.2 Potential impact of Modification 4

The changes in the maximum turbine envelope identified in Table 1-1 will have no material effect on AM radio reception. The turbine locations are unchanged from the approved layout so there is no change in separation from AM radio stations.

3.3 FM RADIO

3.3.1 Overview

FM radio stations serving the Central Tablelands and Orange area are listed below. There are some low power stations in Blayney and Carcoar that have very limited range and are not listed here. The power shown in the table is the effective radiated power (ERP).

Call Sign	Licence	Area	Frequency	Power
2JJJ	National	Central Tablelands	101.9 MHz	80 kW
2ABCFM	National	Central Tablelands	102.7 MHz	80 kW
2ABCRN	National	Central Tablelands	104.3 MHz	80 kW
2CCB	Community	Orange	103.5 MHz	5 kW
2OAG	Commercial	Orange	105.1 MHz	5 k W
2GZF	Commercial	Orange	105.9 MHz	5 kW
2KY	Open Narrowcast	Orange	106.7 MHz	5 kW
2OCW	Community	Orange	107.5 MHz	5 kW
2BS	Commercial	Blayney	89.3 MHz	1 kW
2JJJ	Retransmission	Cadia	88.9 MHz	10 W
2ABCRN	Retransmission	Cadia	89.7 MHz	10 W
2OAG	Retransmission	Cadia	90.5 MHz	10 W
2GF	Retransmission	Cadia	92.9 MHz	10 W

Table 3-2 FM Radio Stations

The Canadian guidelines [3] recommend analysis of FM transmitters that are within 2 km of a turbine. There are no turbines within 2 km of an FM transmitter.

With the exception of areas very close to a turbine (a few hundred metres), FM radio reception should be unaffected.

3.3.2 Potential impact of Modification 4

The location of the turbines is unchanged from that in the approved design. Modification 4 does not introduce any change to FM reception.

Figure 3-3 FM Broadcasting Services within 30 km radius of the wind farm

3.4 TELEVISION

3.4.1 Overview

The terrestrial television services that serve the area neighbouring the wind farm are listed below. All television services are digital.

Service	Channel	Frequency MHz	Polarisation	Power
CENTRAL TABLELANDS				
WIN	35	578.5	Horizontal	350 kW
ABC	36	585.5	Horizontal	350 kW
CBN	37	592.5	Horizontal	350 kW
CTC	38	599.5	Horizontal	350 kW
SBS	39	606.5	Horizontal	350 kW

Table 3-3 Television Services

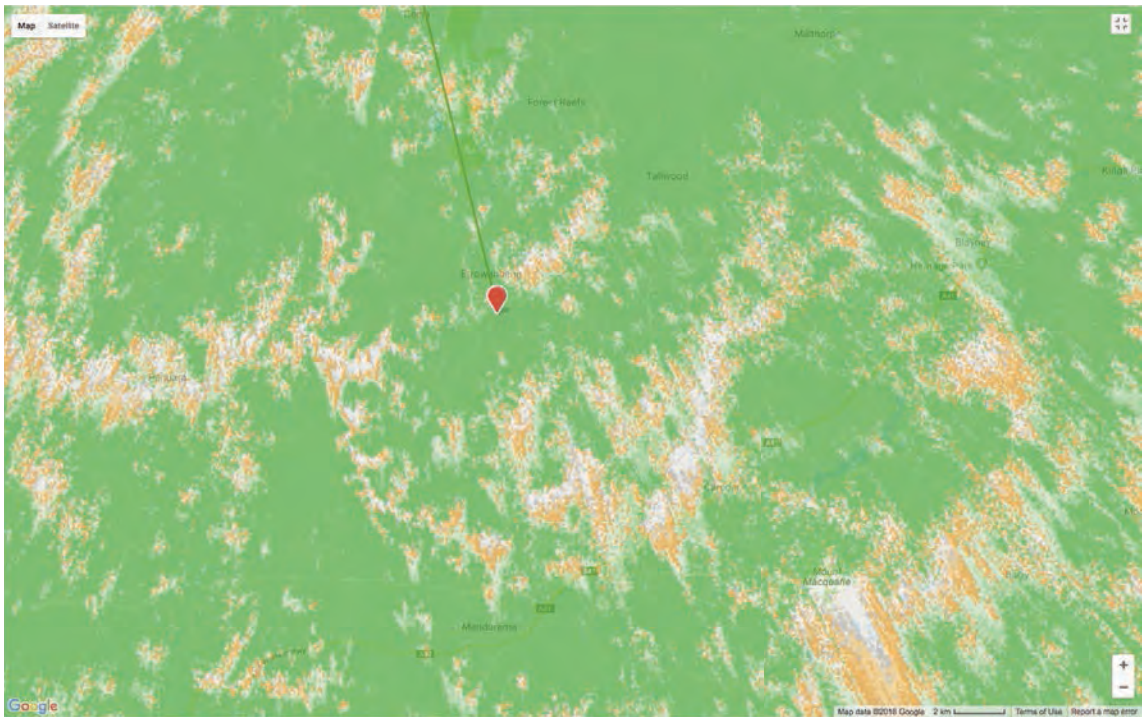


Figure 3-4 ACMA Television coverage predictions for the area

The ACMA television coverage predictions indicate that the Central Tablelands transmitters provide the most effective coverage throughout the area surrounding the wind farm. The coverage areas and channels have changed significantly since the 2010 analysis. Based on theoretical calculations, the areas shown in green in Figure 3-4 have good coverage, those shown in orange have variable coverage and grey or white areas have no coverage.

It is possible for wind farms to interfere with television reception through reflections from the turbine structures and blades. The transmissions from Central Tablelands are horizontally polarised so the reflected signals are of greatest impact when the reflecting surface is horizontal. Vertical surfaces, such as the wind turbines will have little or no impact on the television reception.

The most recent ITU studies provide improved models for analysing interference to digital television, taking into account larger groups of turbines. The analysis process remains complex and incomplete, so field measurements will be performed prior to construction to provide a baseline and more comprehensive data.

The field measurements will be performed in accordance with Condition G3 of the Project Approval:

> *G3. Prior to the commencement of commissioning of the Project, the Proponent shall undertake an assessment of the existing quality of the television, radio and telephone/internet transmission available at a representative sample of receivers located within five kilometres of any wind turbine.*

3.4.2 Potential impact of Modification 4

Modification 4 does not introduce any change to the approved turbine locations, therefore the area potentially affected by the wind farm remains unchanged from that in the approved design.

The increased maximum envelope of the turbines increases the maximum horizontal reflecting area by 25% (blade length increase from 56 m to 70 m). This may increase

the magnitude of the reflected signal when the orientation of the blade (both in rotation and in azimuth) is such that interference can occur.

A detailed assessment of the existing quality of television, radio and telephone/internet will be undertaken prior to the commencement of construction of the Project (Condition G3 of the Project Approval) and should there be any impacts identified once the project is operational then the mitigation measures prescribed in Project Approval condition G4 will be followed.

3.5 SATELLITE TELEVISION

Satellite television services are used at many locations in the vicinity of the wind farm, as there is limited terrestrial television coverage. The satellite antennas are aimed towards a satellite that is in geo-stationary orbit above the equator, with an elevation angle of around 50 degrees above the horizontal. Interference is most unlikely.

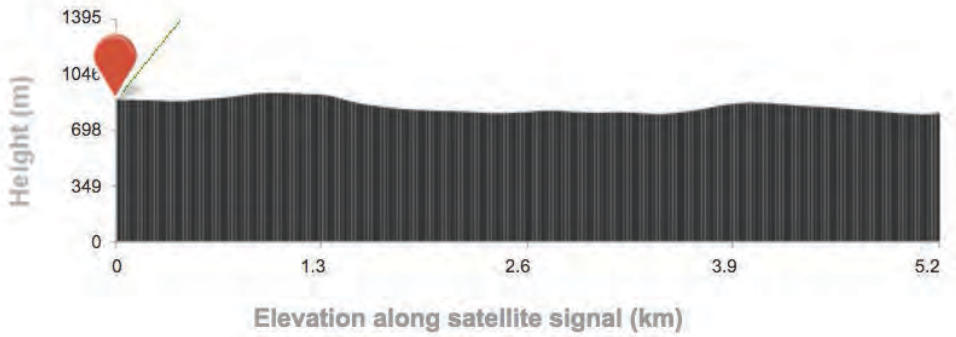


Figure 3-5 Typical Satellite Television reception path

Satellite television reception will not be affected by the changes proposed in Modification 4.

3.6 DIGITAL RADIO BROADCASTING

There are no digital radio broadcasting sites serving the area surrounding Flyers Creek Wind Farm.

Fixed Links

4. FIXED LINKS

4.1 MODIFICATION 4

The following analysis considers the impact of the wind farm on each of the identified fixed links. The analysis considers the maximum turbine envelope as proposed in Modification 4.

The turbine locations are unchanged from the Project Approval: the significant changes in Modification 4 are an increase in maximum blade height of 10 m and an increase in the maximum rotor radius of 29 m (rotor diameter increased from 112 m to 140 m).

4.2 FIXED LINKS – POINT-TO-POINT

Microwave dishes on radio communication towers and buildings are a familiar sight. These dishes are one of the forms of “fixed links” or “point to point” communication systems. The links usually transmit in both directions between two defined sites. The performance of these links is critical to their users and the ACMA spectrum management process has special provisions to ensure that the links can operate without unacceptable interference. The planning process for these links includes assessment of other links in the area and the extent to which they will interfere with the planned link and vice versa.

Figure 4-1 Fixed point-to-point links within 50 km of the wind farm

There is a separate licensing process for each link and a licence is allocated for each direction of the link. The licence numbers for each link are associated. The radio communication site at each end of the link is given a unique identification code, as there may be many links at a particular site. Often there are sites owned by different operators in close proximity, particularly on prominent locations such as Mt Canobolas.

Fixed links pass over the wind farm, some from the Burnt Yards radio site that is within the wind farm area, others from distant locations. The links that pass over the wind farm are summarised in Table 4-1 and can be seen in overview in Figure 4-1.

There may be more than one licenced radio link on any path between locations and this is true of most of the paths. For convenience, each of the paths discussed in this report has been given an alphabetic reference, eg “Path A”, and the various licences are summarised under the relevant link path.

Path	From	To	Licences
A	Burnt Yards	Errol Trig, Blayney	1921832
B	Mt Coonambro	Mt Macquarie	1924312 1924314
C	Pennsylvania Fire Tower	Mt Canobolas	1205850
D	Bigga	Mt Canobolas	1923871
E	Burnt Yards	Cadia Road, Springside	1927529
F	Burnt Yards	Mt Canobolas	1804727 1917964
G	Mt Macquarie (Transgrid)	Mt Canobolas	1144687
H	Mt Macquarie (Reece)	Mt Canobolas	1207663 1566706 1961041
I	Canowindra	Burnt Yards	1921927

Table 4-1 Fixed Links

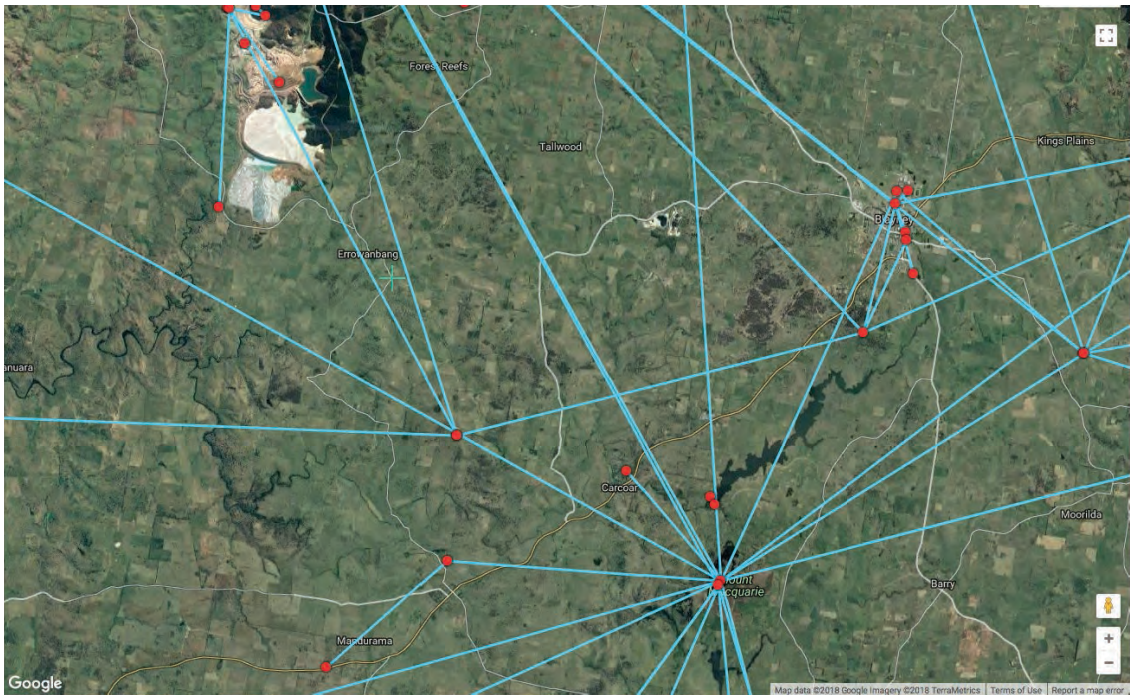


Figure 4-2 Fixed links crossing the wind farm

4.2.1 Path A – Burnt Yards to Errol Trig, Blayney

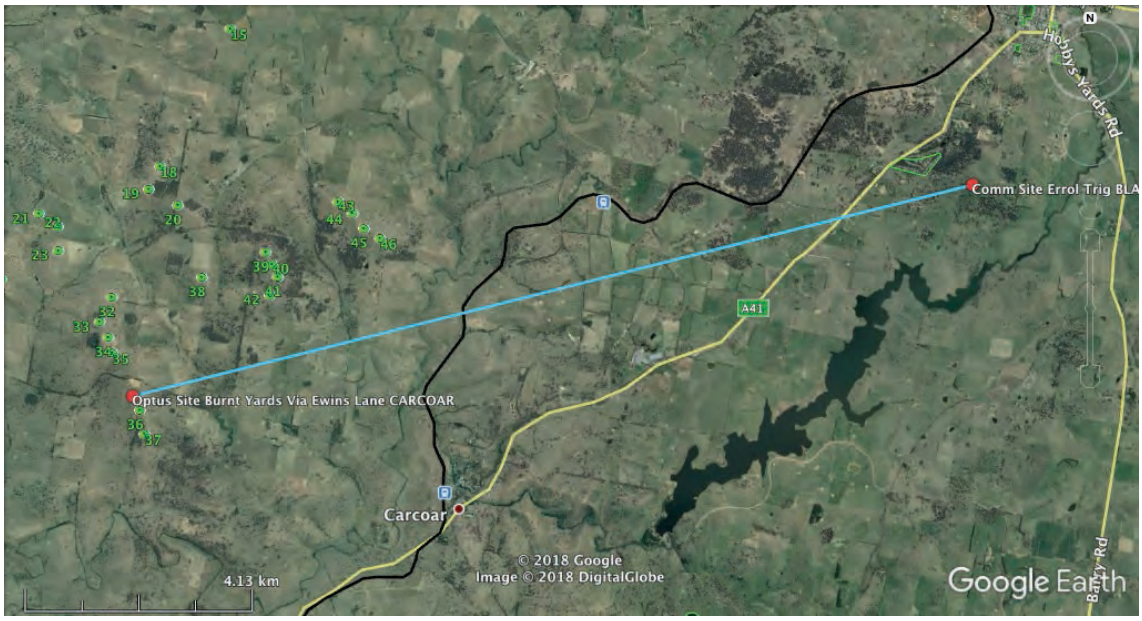


Figure 4-3 Path A – Burnt Yards to Errol Trig

This path does not cross any turbines, the nearest turbine being Turbine 36. The path is approximately 270 metres from the centre of Turbine 36.

A detail of the area around Turbine 36 is shown in Figure 4-4, with the area swept by the turbine blades show as a circle in red.

Figure 4-4 Path A – Detail at Burnt Yards

Approved Project
The wind farm layout in the approved project will not affect this path.

Potential impact of Modification 4
The changes proposed in Modification 4 have no impact on this path: it remains unaffected by the wind farm.

4.2.2 Path B – Mt Coonambro to Mt Macquarie

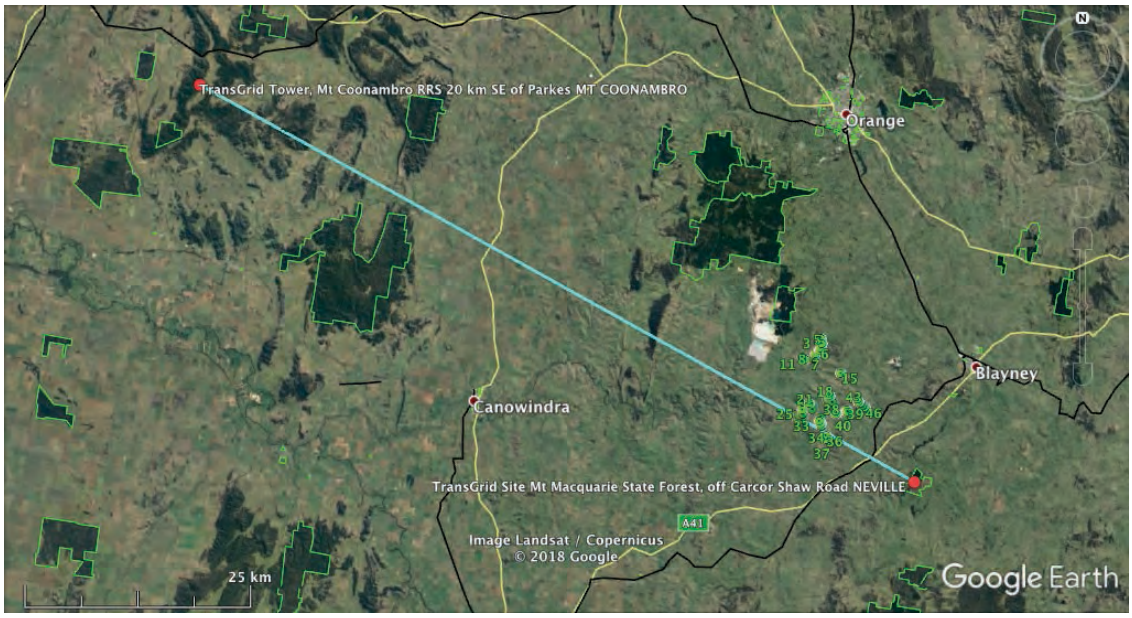


Figure 4-5 Path B – Mt Coonambro to Mt Macquarie

The path travels over Turbine 31 and through a group of turbines. The first Fresnel zone around the path is plotted in Figure 4-6, showing the relationship with the turbines in this area.

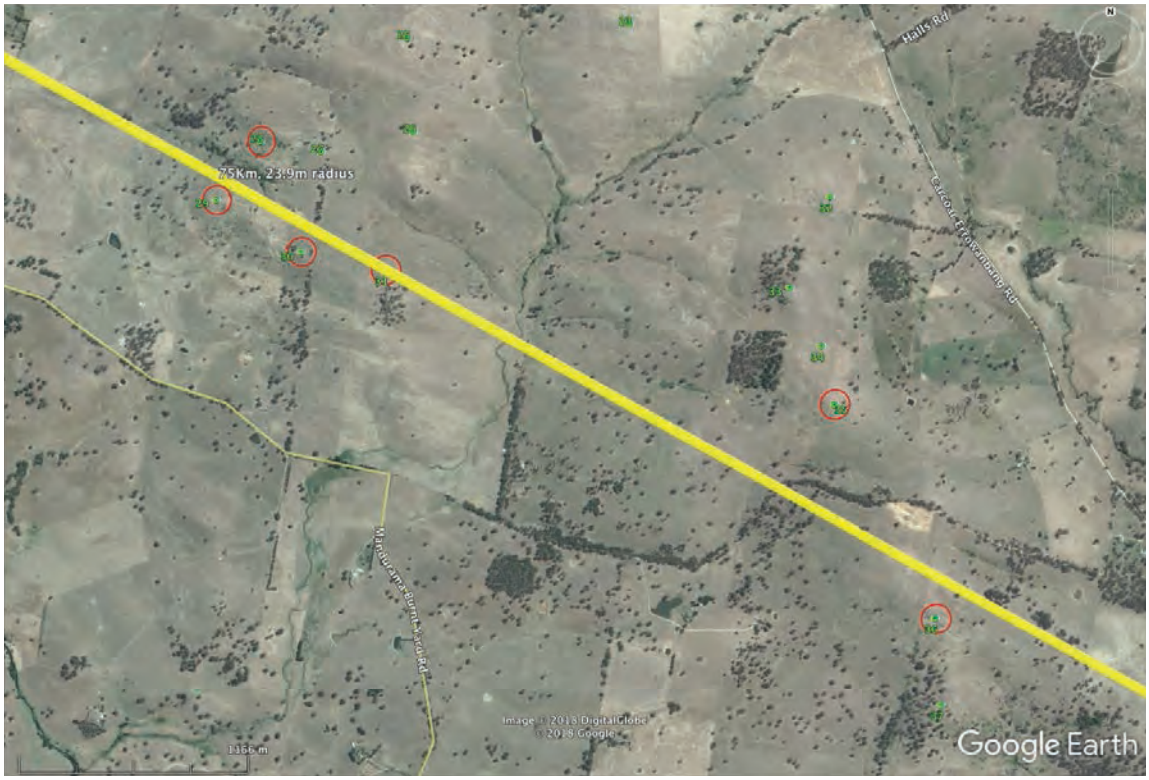


Figure 4-6 Path B - First Fresnel zone shown in yellow. The red circles indicate the area swept by the turbine blades

The turbine closest to the path is Turbine 31, which in plan view is directly on the path between the radio sites. The path is well above the turbine, as the transmitting and receiving sites are at higher elevation.

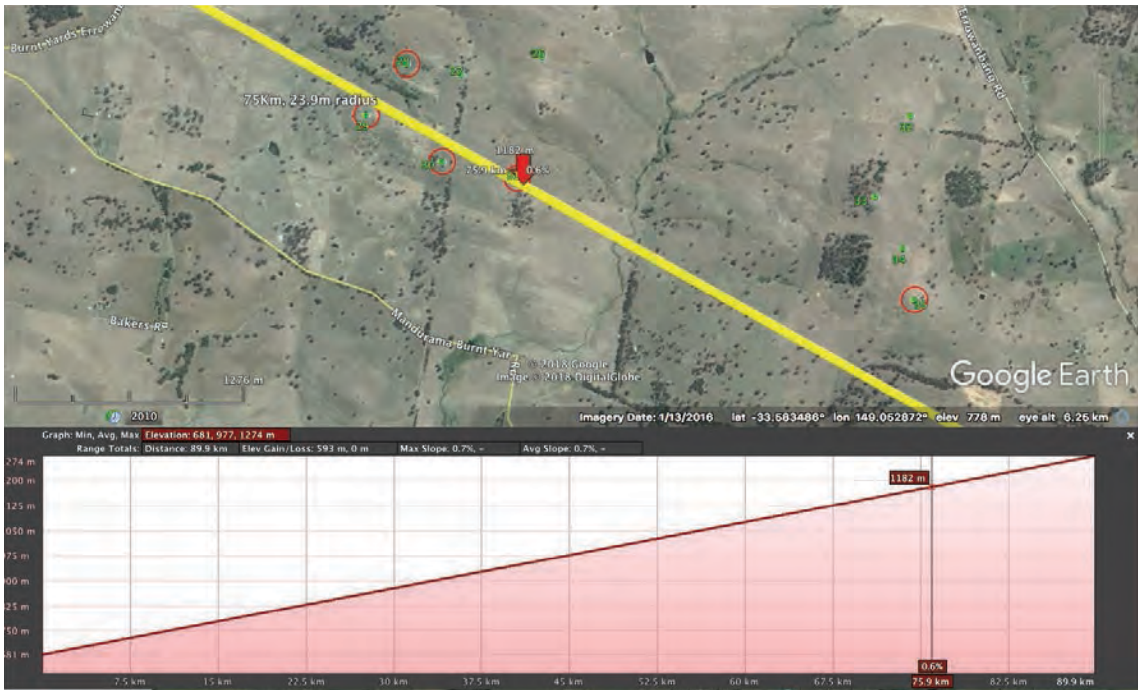


Figure 4-7 Line of sight path elevation

The calculations in the following table have been based on the link with the lowest frequency on this path, as the lowest frequency has the largest Fresnel zone radius.

Location	Ground m AHD	LOS Height m AHD	Refraction (k=1) m	Fresnel (F_1) m	Blade Tip m AGL	Clearance m
Mt Coonambro	621	681				
Turbine 31	835	1182	0	25	160	162 m
Mt Macquarie	1210	1277				

Table 4-2 Clearance for Path B at Turbine 31 – Typical Conditions

Effect of changes in propagation conditions

The refractive index of the atmosphere varies with time and this has the effect of reducing or increasing the height of the radio path above ground. Under normal atmospheric conditions the radio ray line is refracted away from the ground, reducing the effect of the earth's curvature. The apparent "flattening" of the earth's curvature is described as an increase in the radius of the earth by a factor "k", usually taken as 1.33 under normal atmospheric conditions. The calculations and ray line predictions in this report use a conservative "k" value of 1.0.

Approved Project

There is ample clearance between the tip of the turbine blades and the first Fresnel zone radius; the clearance exceeds twice the first Fresnel zone radius (2 x 25 m).

Modification 4

Modification 4 has no impact on this path. Path B is not affected by the wind farm.

4.2.3 Path C – Pennsylvania Fire Tower to Mt Canobolas

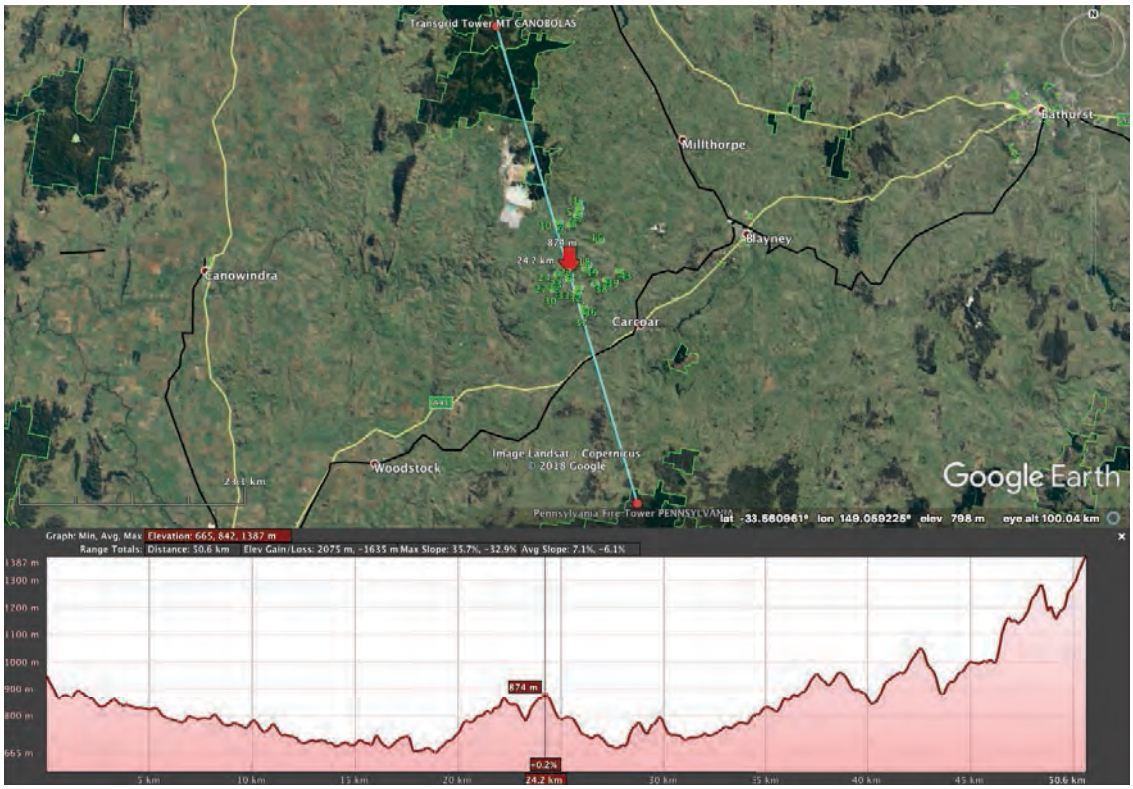


Figure 4-8 Path C – Pennsylvania Fire Tower to Mt Canobolas

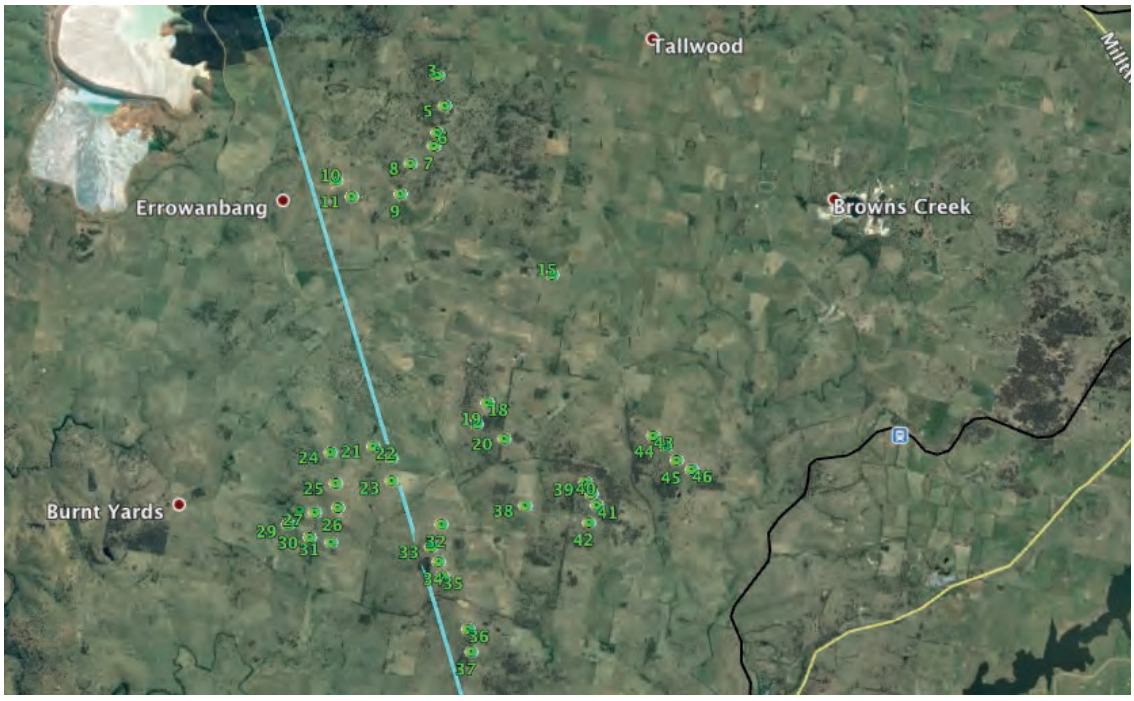


Figure 4-9 Path C - Detail

The path travels over or close to Turbines 21, 22 and 23. The first Fresnel zone around the path is plotted below, showing the relationship with the turbines in this area.

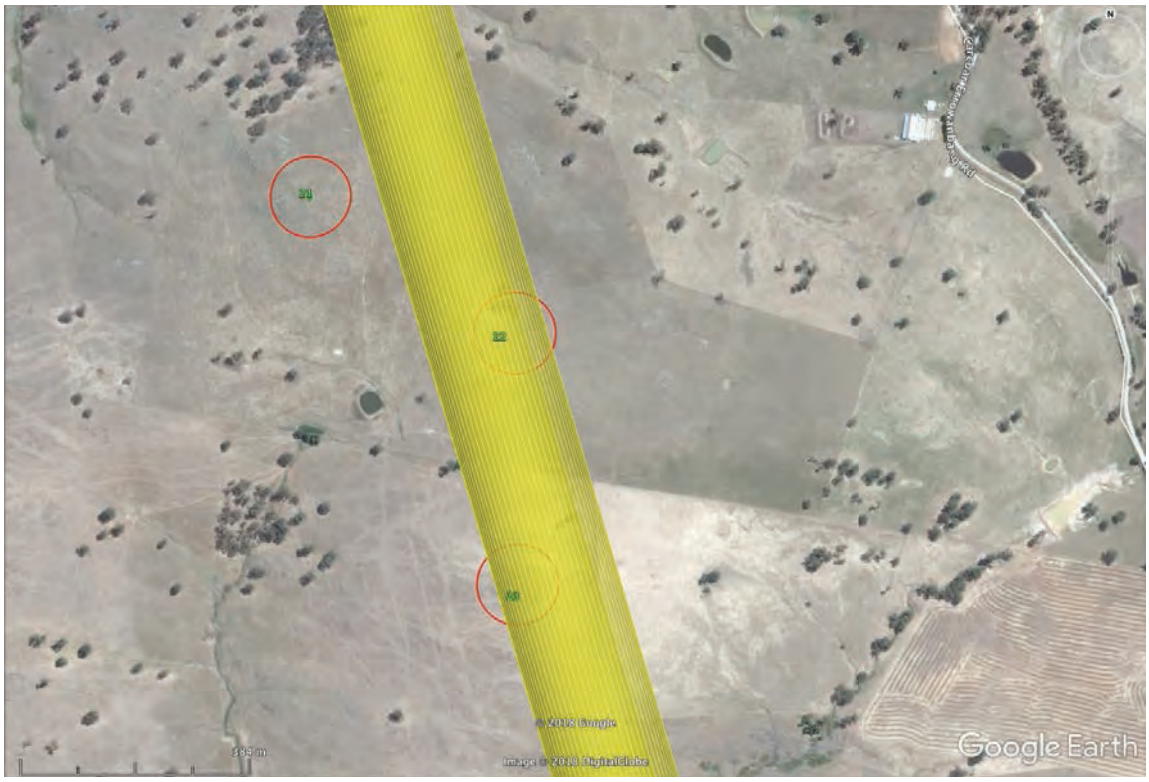


Figure 4-10 Path C - First Fresnel zone shown in yellow. The red circles indicate the area swept by the turbine blades

The turbines closest to the path are Turbines 22 and 23.

The calculations in the following table have been based on the link with the lowest frequency on this path (451.475 MHz), as the lowest frequency has the largest Fresnel zone radius. The antenna heights for this link are not specified in the ACMA database so a height of 10 metres above ground has been assumed.

Location	Ground m AHD	LOS Height m AHD	Refraction (k=1) m	Fresnel (F_1) m	Blade Tip m AGL	Clearance m
Pennsylvania	621	10				
Turbine 22	876	1168	0	91	160	41 m
Turbine 23	835	1164	0	91	160	78 m
Mt Canobalos	1210	10				

Table 4-3 Clearance for Path C at Turbine 31 – Modification 4

Approved Project

There is ample clearance between the tip of the turbine blades and the first Fresnel zone radius. The calculation has been based on an assumed height of 10 metres for the transmitting and receiving antennas. The antenna height (and therefore the clearance) is expected to be higher than this assumed value

Modification 4

The clearance shown in Table 4-3 assumes the turbine envelope for Modification 4. Even with the greater turbine envelope there is ample clearance between the tip of the turbine blades and the first Fresnel zone radius. Modification 4 does not affect Path C.

4.2.4 Path D – Bigga to Mt Canobolas

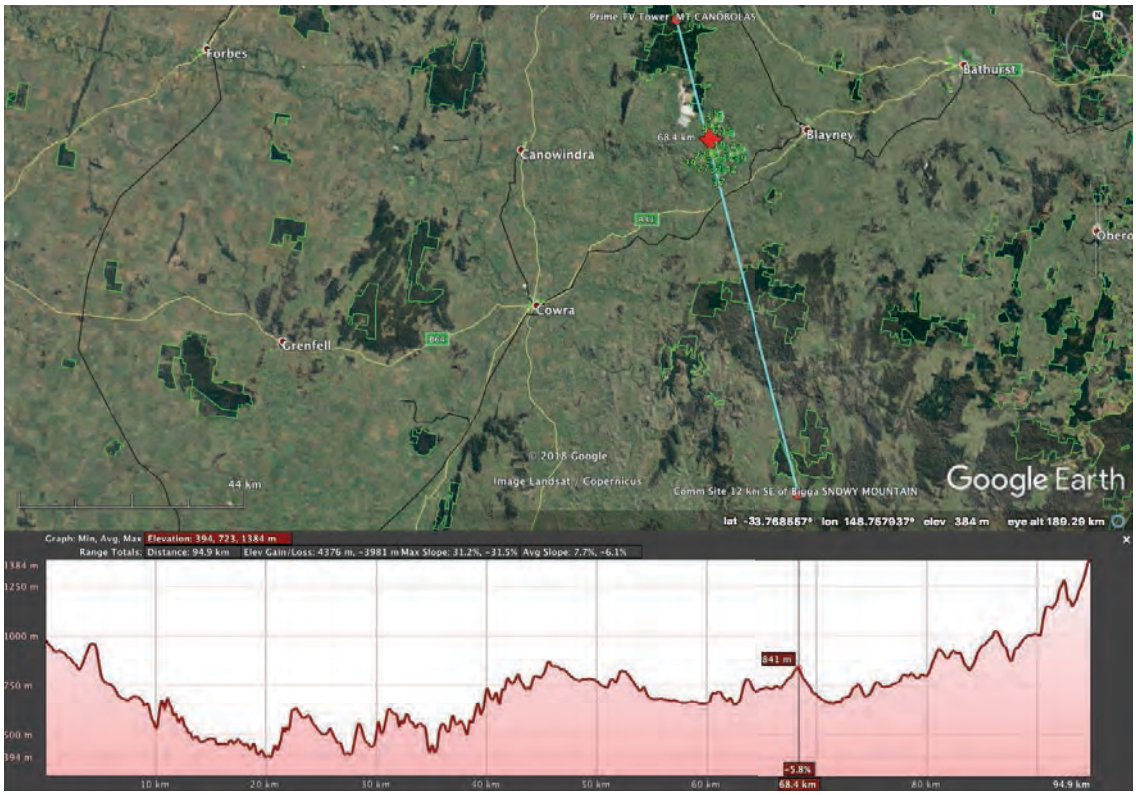


Figure 4-11 Path D – Bigga to Mt Canobolas

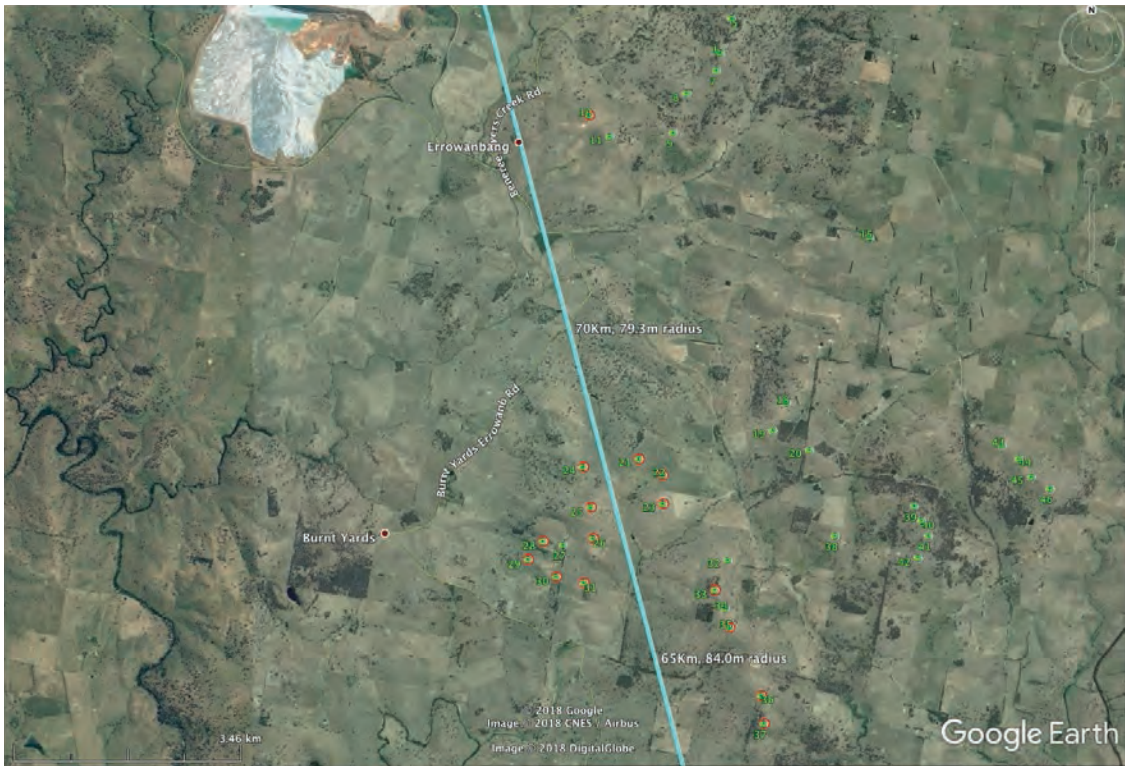


Figure 4-12 Path D - Detail

The path travels close to Turbines 21, 22, 23, 24, 25 and 26. The first Fresnel zone around the path is plotted below, showing the relationship with the turbines in this area.

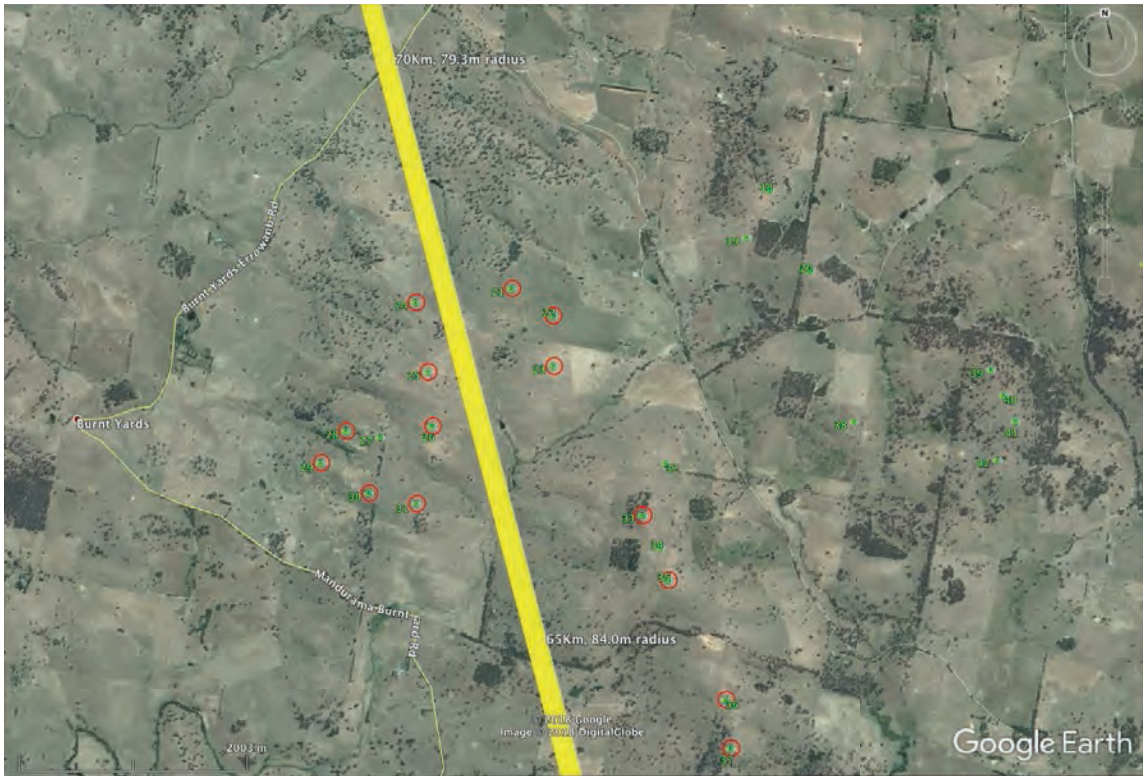


Figure 4-13 Path D - First Fresnel zone shown in yellow. The red circles indicate the area swept by the turbine blades

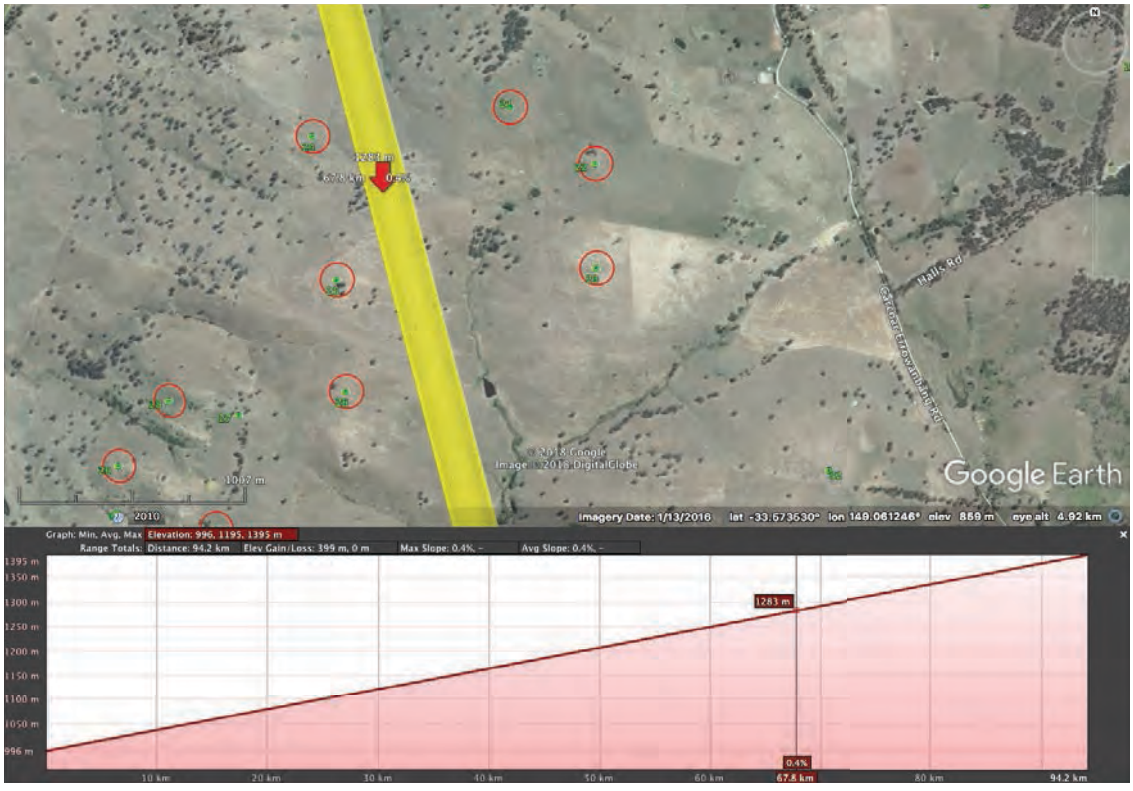


Figure 4-14 Line of sight path elevation is 1283 m near these turbines

The calculations in the following table have been based on the link with the lowest frequency on this path (854.05 MHz), as the lowest frequency has the largest Fresnel zone radius. The calculated clearances consider only the clearance of the ray line above the turbines. The horizontal offset, which has not been included, would increase the clearance.

Location	Ground m AHD	LOS Height m AHD	Refraction (k=1) m	Fresnel (F_1) m	Blade Tip m AGL	Clearance m
Pennsylvania	621	10				
Turbine 24	822	1283	0	82	160	219 m
Turbine 25	860	1283	0	82	160	181 m
Mt Canobalos	1210	10				

Table 4-4 Clearance for Path D in vertical plane – Modification 4

Approved Project

There is ample clearance between the tip of the turbine blades and the first Fresnel zone radius (more than twice the first Fresnel zone).

Modification 4

Modification 4 does not affect Path D. There is ample clearance.

4.2.5 Path E – Burnt Yards to Cadia Road

Figure 4-15 Path E – Burnt Yards to Cadia Road

Figure 4-16 Path E - Detail

The path travels close to Turbines 21, 23, 33 and 35. The first Fresnel zone around the path is plotted below, showing the relationship with the turbines in this area.

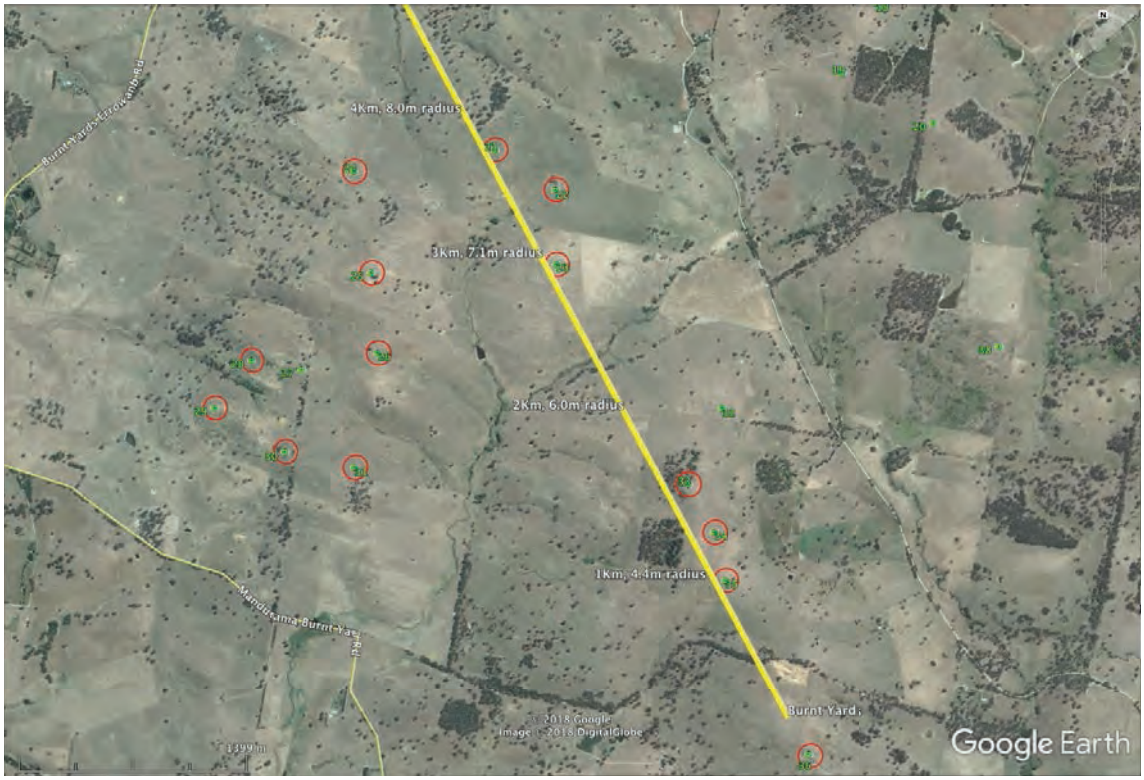


Figure 4-17 Path E - First Fresnel zone shown in yellow. The red circles indicate the area swept by the turbine blades

The calculations in the following tables have been based on the link with the lowest frequency on this path (14.683 GHz), as the lowest frequency has the largest Fresnel zone radius.

The vertical clearance calculations below ignore the horizontal offset of the turbine from the radio path. The horizontal offset is calculated separately.

Location	Ground m AHD	LOS Height m AHD	Refraction (k=1) m	Fresnel (F_1) m	Blade Tip m AGL	Clearance m
Burnt Yards	885	25				
Turbine 21	856	905	0	8	160	-119 m
Turbine 23	860	906	0	7	160	-121 m
Turbine 33	863	907	0	5	160	-121 m
Turbine 34	901	908	0	5	160	-158 m
Turbine 35	893	908	0	4	160	-121 m
Cadia Road	877	10				

Table 4-5 Clearance for Path E in vertical plane – Modification 4

Location	Distance m	Fresnel (F_1) m	Blade Tip m	Clearance m
Turbine 21	61	8	70	**-17 m**
Turbine 23	61	7	70	**-16 m**
Turbine 33	132	5	70	57 m
Turbine 34	133	5	70	58 m
Turbine 35	60	4	70	**-14 m**

Table 4-6 Clearance for Path E in horizontal plane – Modification 4

Approved Project

The clearance from each of the turbines is 29 m greater than that shown in in Table 4-6, so none of the turbines infringes the first Fresnel zone.

However, the clearance calculated here is less than the error in topographic data and antenna position data so either a detailed site survey should be performed or additional clearance provided within the micro-siting allowance.

Modification 4

The increased maximum turbine envelope in Modification 4 has been taken into account in Table 4-6. Turbines 21, 23 and 35 have insufficient clearance from Path E in their approved centre point location, however the turbines can be relocated sufficiently within the micro-siting allowance of the existing Project Approval to ensure that sufficient clearance is maintained.

4.2.6 Path F – Burnt Yards to Mt Canobolas

Figure 4-18 Path F – Burnt Yards to Mt Canobolas

Figure 4-19 Path F – Detail 1

Figure 4-20 Path F – Detail 2

The path travels close to Turbines 10, 32, 33, 34 and 35. The first Fresnel zone around the path is plotted below, showing the relationship with the turbines in this area.

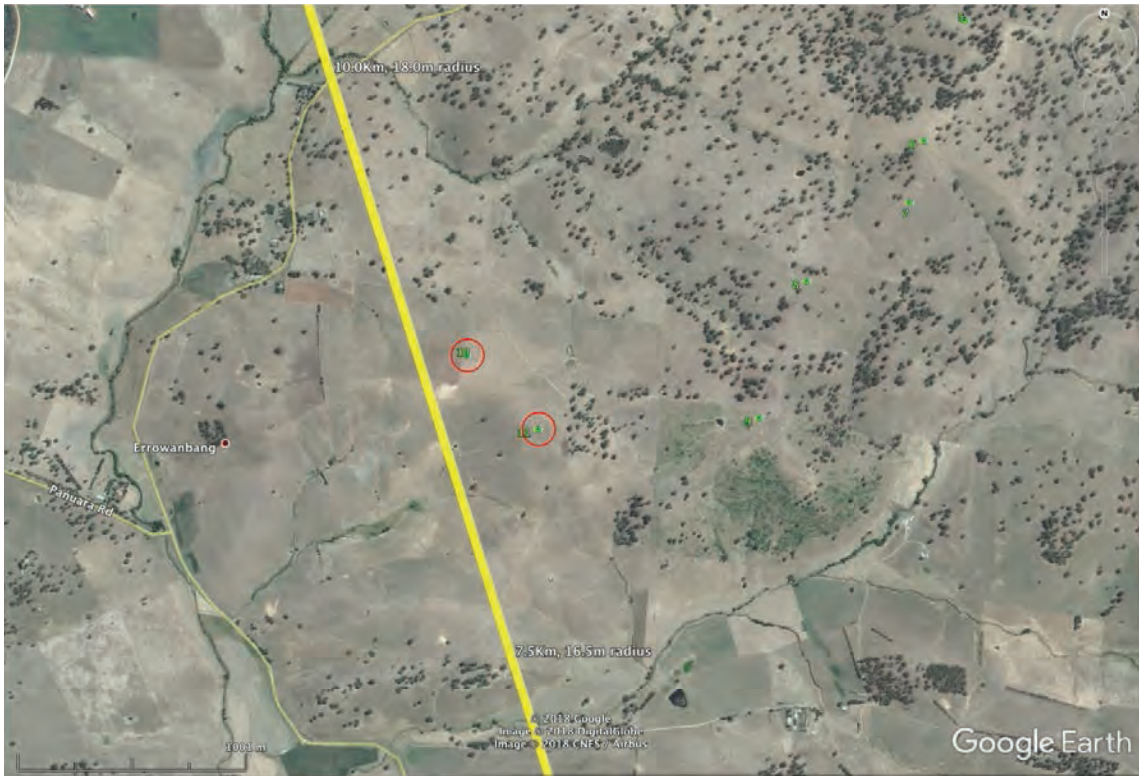


Figure 4-21 Path F - First Fresnel zone shown in yellow – northern portion

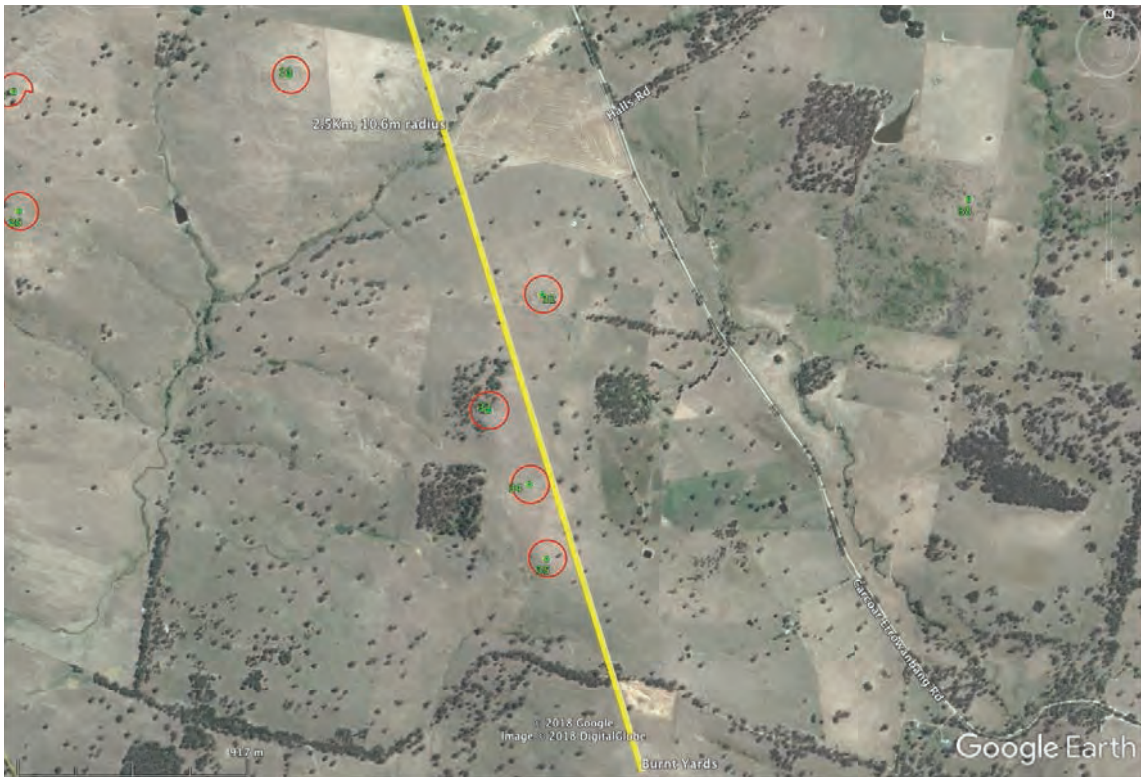


Figure 4-22 Path F - First Fresnel zone shown in yellow – southern portion

The calculations in the following tables have been based on the link with the lowest frequency on this path (6.137925 GHz), as the lowest frequency has the largest Fresnel zone radius.

Location	Distance m	Fresnel (F_1) m	Blade Tip m	Clearance m
Turbine 10	165	18	70	77 m
Turbine 32	176	9	70	97 m
Turbine 33	149	8	70	71 m
Turbine 34	85	8	70	**7 m**
Turbine 35	104	7	70	**27 m**

Table 4-7 Clearance for Path F in horizontal plane – Modification 4

Approved Project

The clearance for Path F in the approved project is 29 m greater than that shown in Table 4-7. All turbines have sufficient clearance from the first Fresnel zone, within the accuracy of the map interpolation and available data.

Modification 4

The clearances under Modification 4 are shown in Table 4-7. As in the approved project, Turbines 10, 32 and 33 have sufficient clearance from Path F.

Turbines 34 and 35 are clear of the first Fresnel zone, within the accuracy of the map interpolation and available data.

It is normal practice to provide clearance of twice the first Fresnel Zone at these frequencies, so the location of Turbine 35 should be adjusted from its approved centre point location within the micro-siting conditions of the Project Approval to ensure sufficient clearance is maintained.

4.2.7 Path G – Reece Site, Mt Macquarie to Mt Canobolas

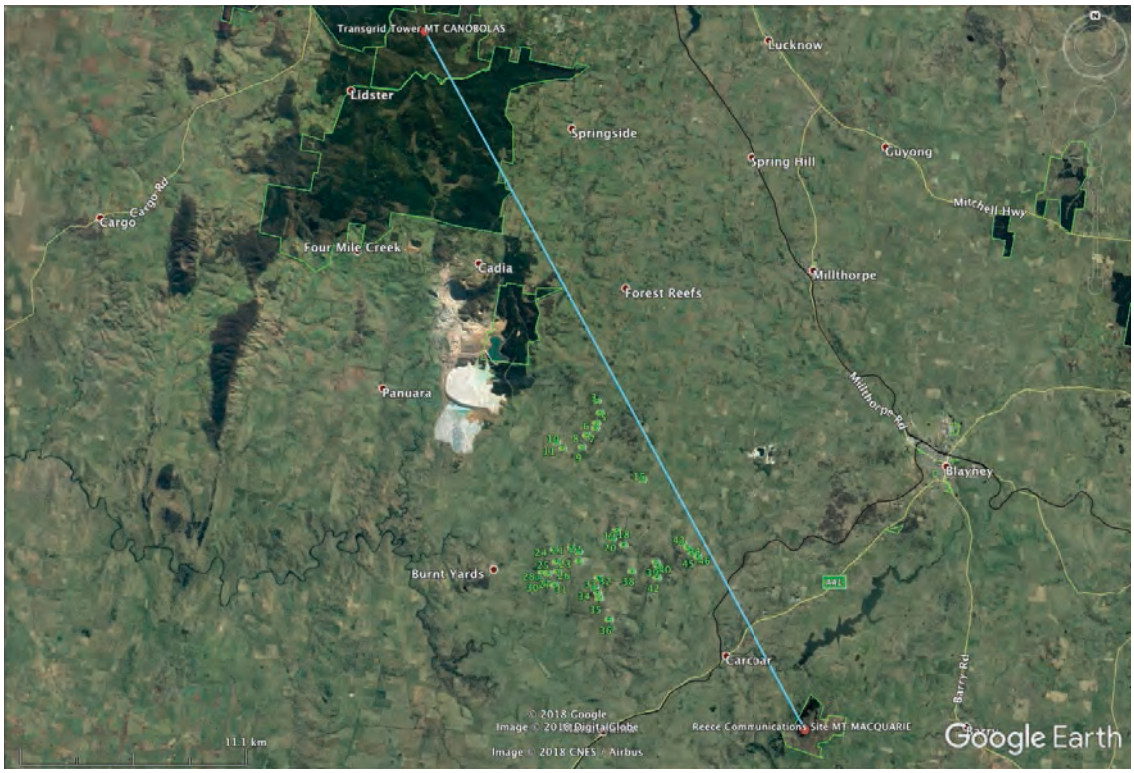


Figure 4-23 Path G – Mt Macquarie to Mt Canobolas

Figure 4-24 Path G – Detail showing locations of turbines 44, 45 and 46

The path travels near Turbines 44, 45 and 46. The first Fresnel zone around the path is plotted below, showing the relationship with the turbines in this area.

Figure 4-25 Path G - First Fresnel zone shown in yellow

The diagrams and the calculations in the following table have been based on the link with the lowest frequency on this path (450.6 MHz), as the lowest frequency has the largest Fresnel zone radius.

Location	Distance m	Fresnel (F_1) m	Blade Tip m	Clearance m
Turbine 44	855	70	70	715 m
Turbine 45	809	70	70	669 m
Turbine 46	650	70	70	510 m

Table 4-8 Clearance for Path G in horizontal plane

Approved Project

There is ample clearance from each turbine to Path G.

Modification 4

Path G is not affected by Modification 4.

4.2.8 Path H – Transgrid Site, Mt Macquarie to Mt Canobolas

Figure 4-26 Path H – Transgrid Mt Macquarie to Transgrid Mt Canobolas

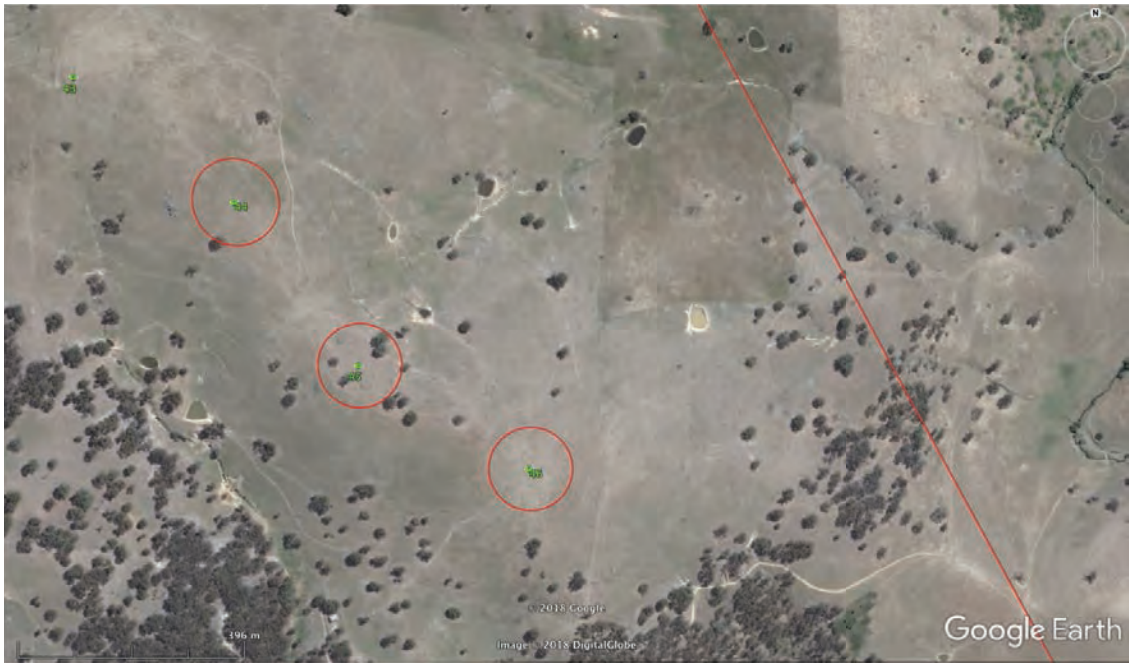


Figure 4-27 Path H – Detail

The path travels close to Turbines 44, 45 and 46. The first Fresnel zone around the path is plotted below, showing the relationship with the turbines in this area.

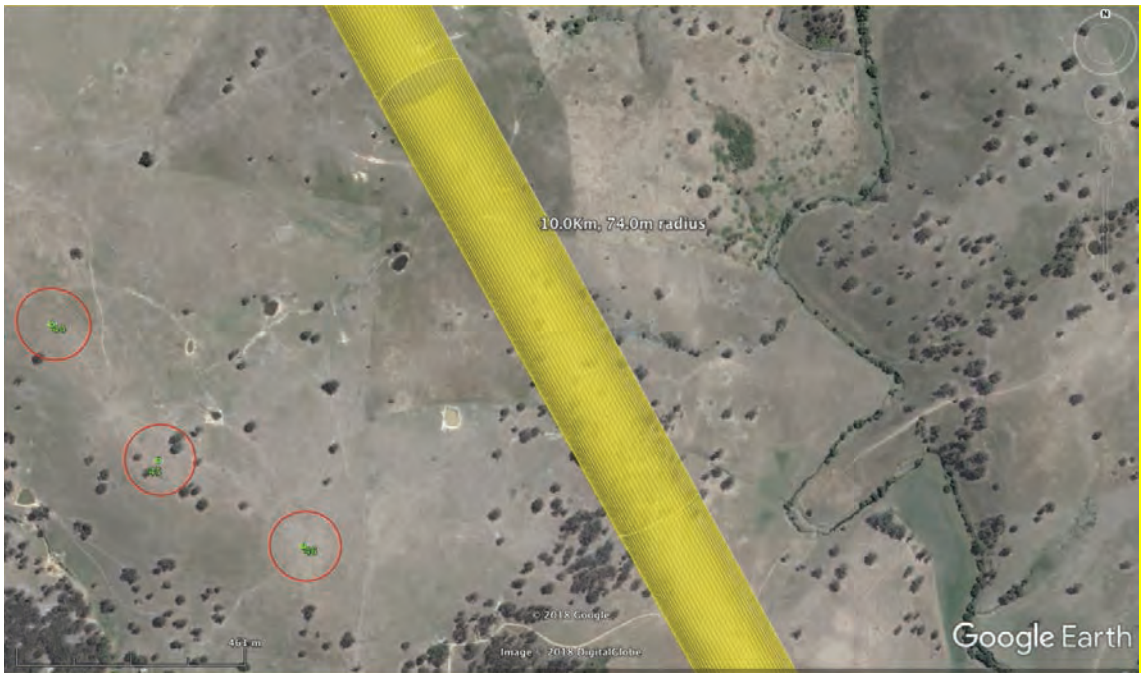


Figure 4-28 Path H - First Fresnel zone shown in yellow

The calculations in the following table have been based on the link with the lowest frequency on this path (404.65 MHz), as the lowest frequency has the largest Fresnel zone radius.

Location	Distance m	Fresnel (F_1) m	Blade Tip m	Clearance m
Turbine 44	850	75	70	705 m
Turbine 45	810	74	70	666 m
Turbine 46	640	74	70	496 m

Table 4-9 Clearance for Path H in horizontal plane

Approved Project

There is ample clearance from each turbine to Path H.

Modification 4

Path H is not affected by Modification 4.

4.2.9 Path I – Burnt Yards to Canowindra

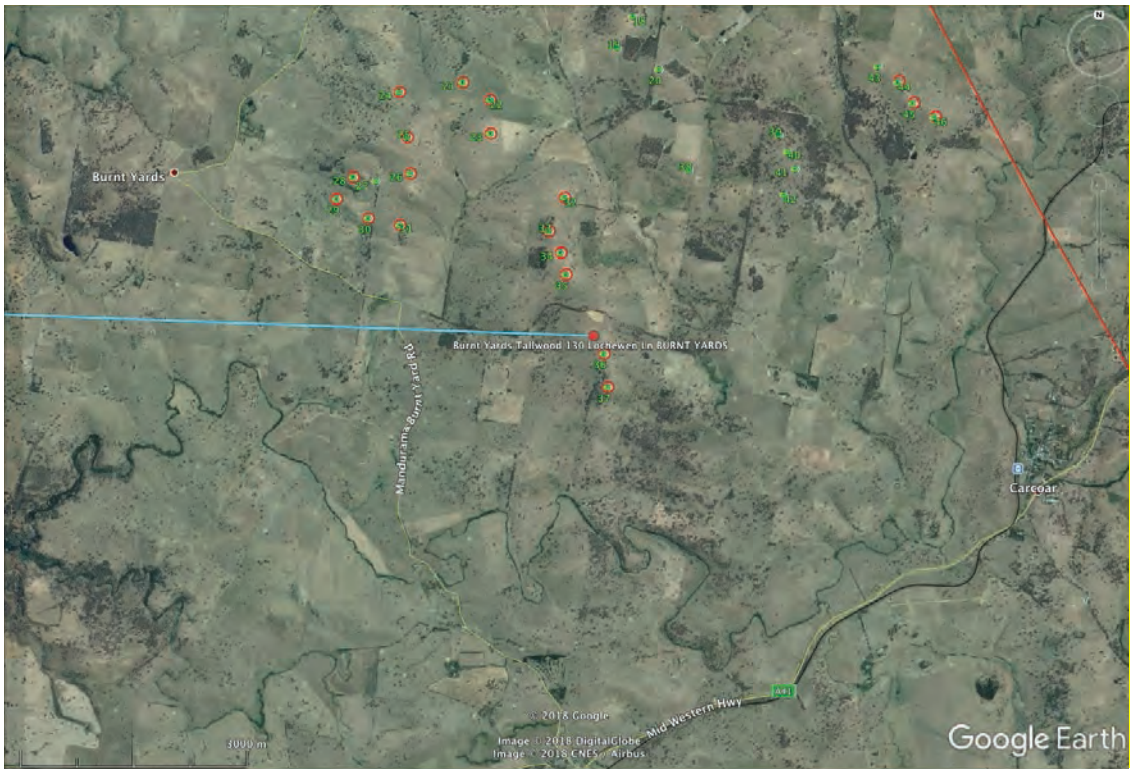


Figure 4-29 Path I – Burnt Yards to Canowindra

Figure 4-30 Path I – Detail

The Burnt Yards site is close to Turbines 35 and 36. The first Fresnel zone around the path is plotted below, showing the relationship with the turbines in this area.

Figure 4-31 Path I - First Fresnel zone shown in yellow

The calculations in the following table have been based on the link with the lowest frequency on this path (7.79 GHz), as the lowest frequency has the largest Fresnel zone radius.

Location	Distance m	Fresnel (F_1) m	Blade Tip m	Clearance m
Turbine 35	780	4	70	706 m
Turbine 36	Behind Path	-	70	Not applicable

Table 4-10 Clearance for Path I in horizontal plane

Approved Design

There is ample clearance from each turbine to Path I.

Modification 4

Path I is not affected by Modification 4.

4.3 CLEARANCE FROM ELECTRICITY TRANSMISSION LINES

The wind farm will connect to the electricity transmission network through a 132 kV transmission line. The transmission line may be constructed overhead or partly overhead and partly underground. For this analysis it is assumed that the line is all overhead and that the pole height is approximately 24 m.

The effect of the transmission line on each of the fixed links is discussed in this section.

Figure 4-32 132 kV Electricity Transmission Line Route

4.3.1 Path C – Clearance from 132 kV Transmission Line

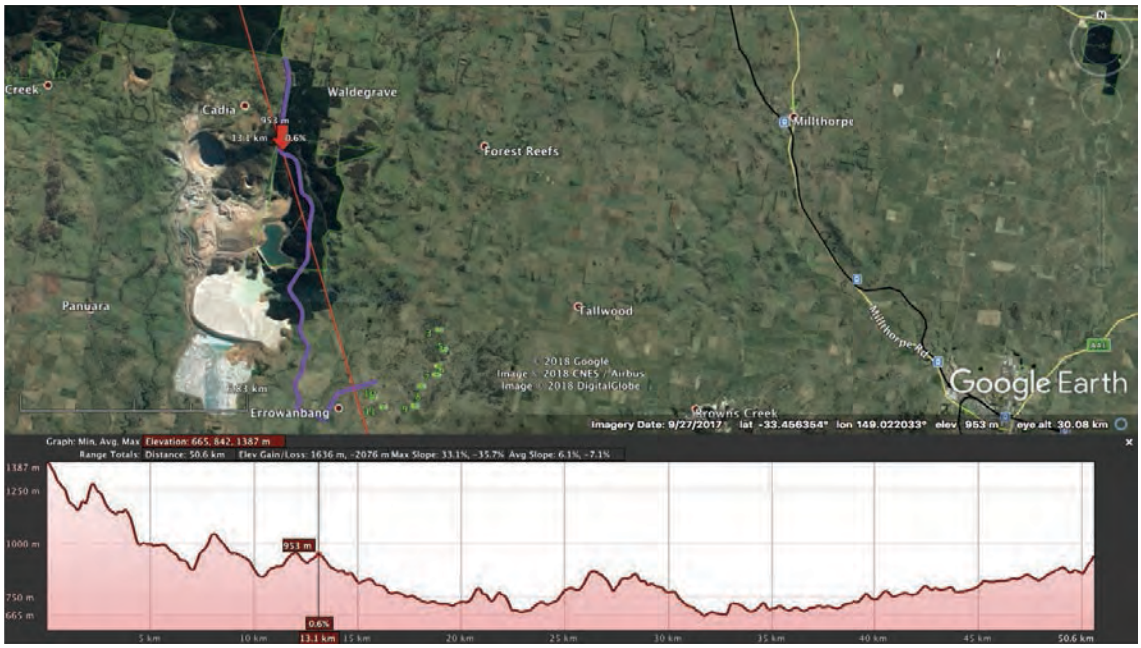


Figure 4-33 Path C - Terrain at 132 kV line crossing

Path C crosses the proposed transmission line at several places. The location with highest terrain and least clearance is at 13.1 km from Mt Canobolas, where the terrain height is 953 m. The ray line at this location is at 1283 m and the first Fresnel zone radius is approximately 80 m. There is ample clearance between the radio path, with a lowest elevation of 1203 m and the top of the pole at approximately 977 m.

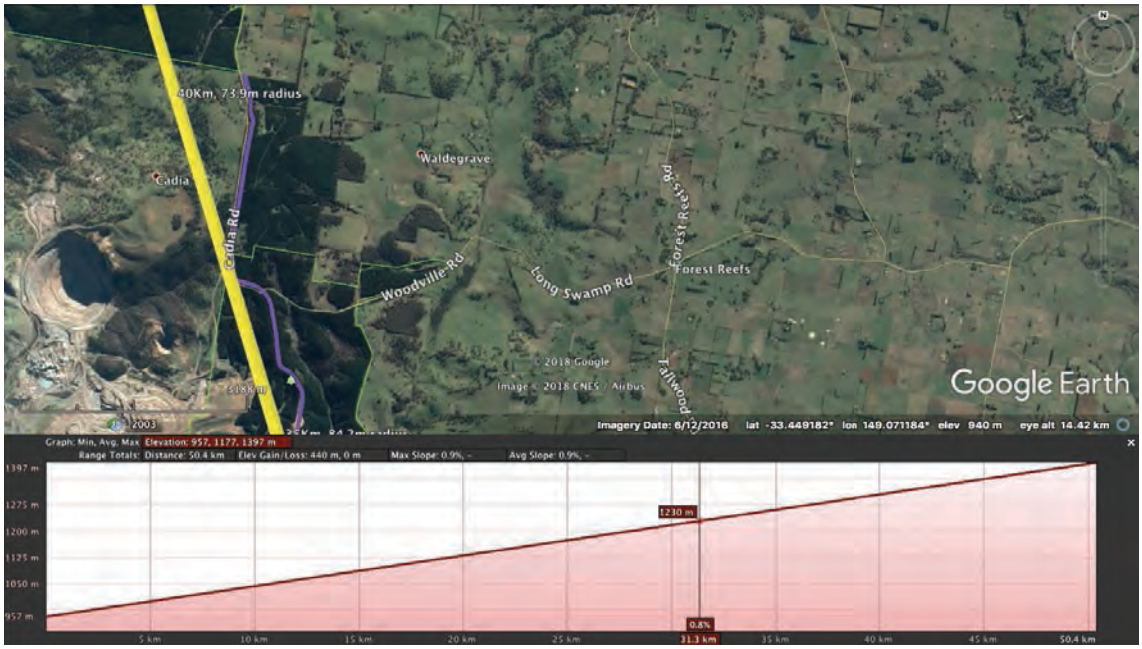


Figure 4-34 Path C ray line at 132 kV line crossing

Potential impact of Modification 4

Modification 4 has no impact on Path C.

4.3.2 Path D – Clearance from 132 kV Transmission Line

Path D crosses the proposed transmission line route at two places. The location with the highest terrain is at 16.7 km from Mt Canobolas, where the ground level is 806 m. At this location the radio path is at 1324 m and the first Fresnel zone radius is approximately 70 metres. The clearance to the first Fresnel zone above a 24 m pole is 424 metres.

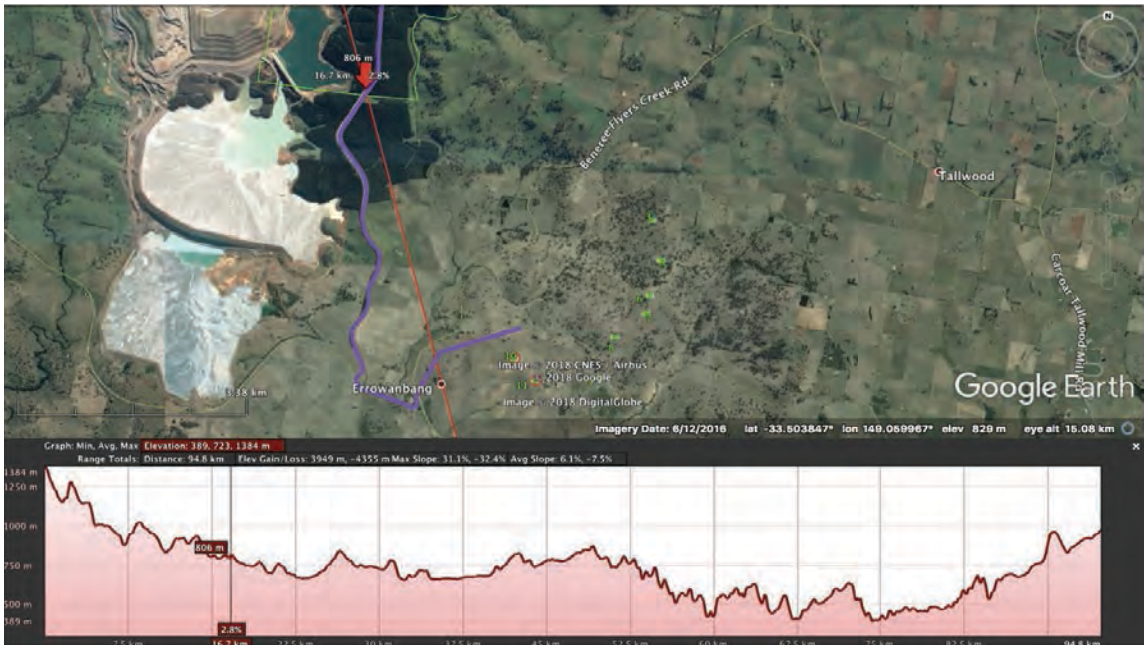


Figure 4-35 Path D - Terrain profile showing northern crossing of 132 kV line

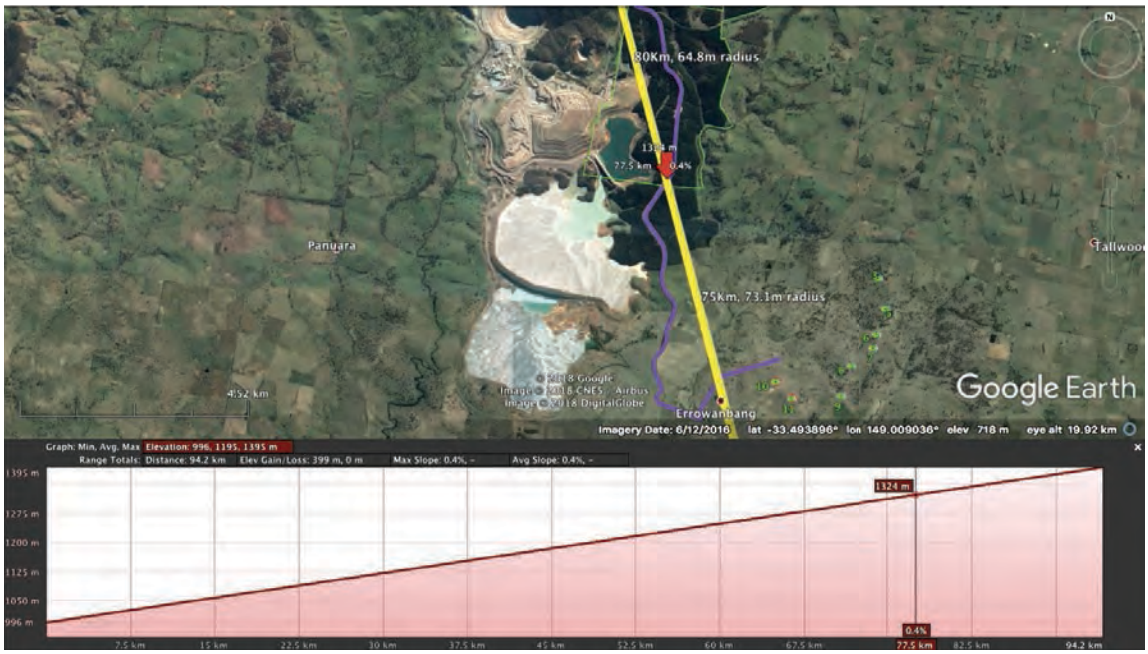


Figure 4-36 Path D - Ray line at northern crossing of 132 kV transmission line

Potential impact of Modification 4

Modification 4 has no impact on Path D.

4.3.3 Path E - Clearance from 132 kV Transmission Line

Path E passes over the proposed transmission line route.

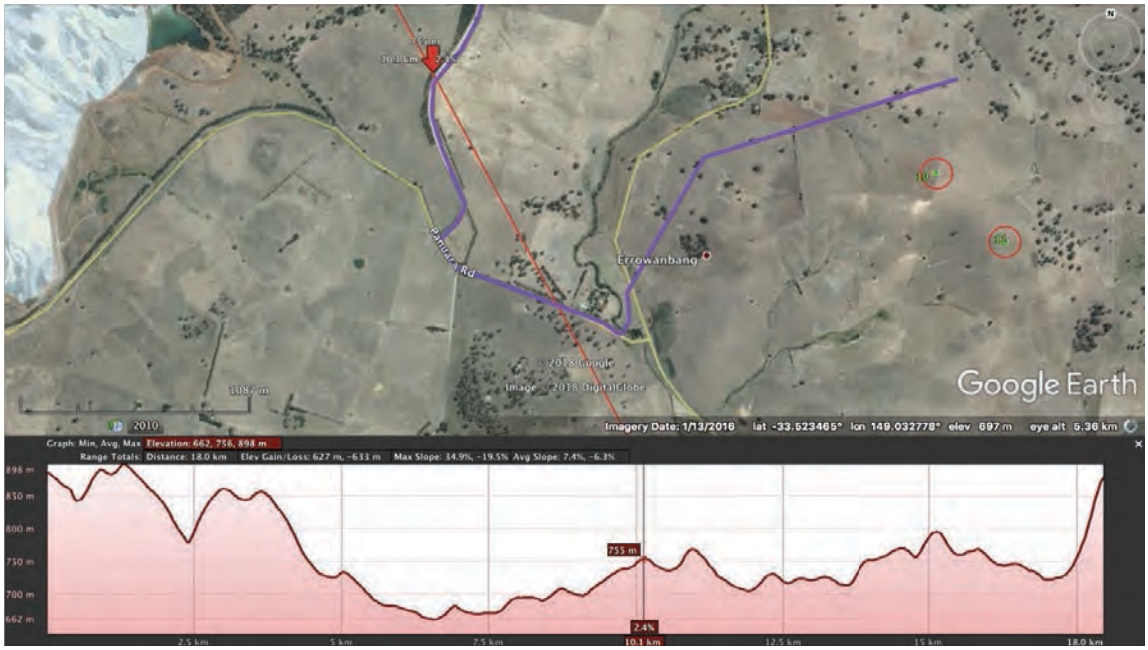


Figure 4-37 Path E - Terrain at the 132 kV transmission line is at 755 m AHD

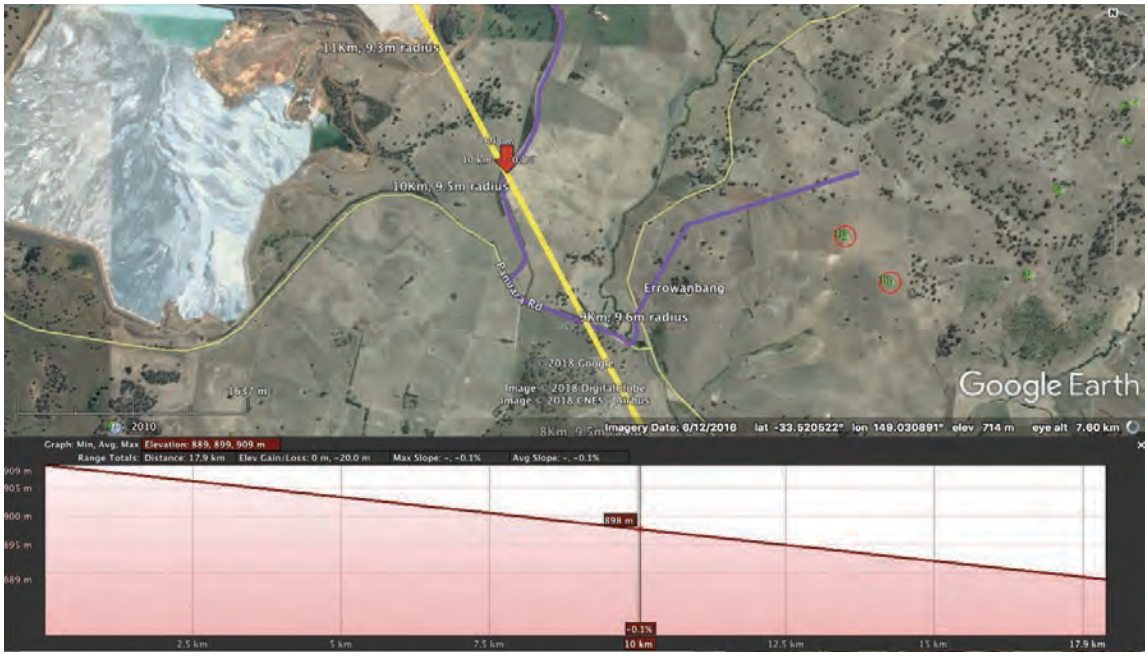


Figure 4-38 Path E - Ray line at the transmission line crossing is at 898 m

The highest point on the terrain at the 132 kV line is marked with a red arrow; the ground level here is 755 m. The radio ray line (centre of beam) is at 898 m at this point, providing 143 m clearance to the centre of the ray line for k = 1.33 and the first Fresnel zone radius is 9.5 m at this point. There is ample clearance above the approximate 24 m power line poles. The terrain height is 703 m at the southern crossing of the ray line.

Potential impact of Modification 4

Modification 4 has no impact on Path E.

4.3.4 Path F – Clearance from 132 kV Transmission Line

The ray line for Path F crosses the transmission line at several places. The terrain is highest near Cadia, at 17.6 km from Burnt Yards.

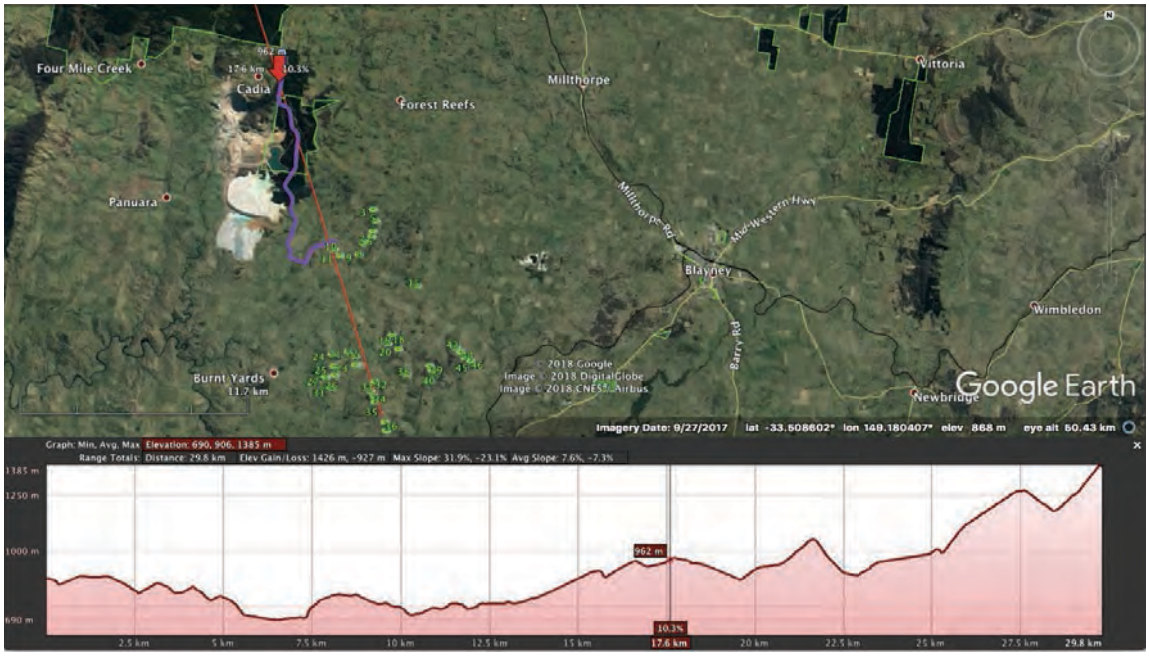


Figure 4-39 Path F crosses the 132 kV transmission line route

At 16.3 km from Burnt Yards the terrain height is 948 m. The ray line is at 1181 m at this point, providing ample clearance above the approximate 24 m power line poles.

Potential impact of Modification 4

Modification 4 has no impact on Path F.

Figure 4-40 Path F Ray line at the northern crossing of Cadia Road

4.4 POINT-TO-MULTIPOINT

Figure 4-41 Fixed Point to multipoint sites within 30 km radius

There are many point to multipoint services within 30 km radius of the wind farm. The central point of these services is identified in the ACMA database but the remote points are not identified. The services are listed in the table below. Paging services have been included in this category.

Client Name	System	MHz	W	Site Name	Site Id
NSW Rural Fire Service	155113	148.5875	160	Mt Macquarie	10652
NSW Rural Fire Service	121649	148.5875	500	Mt Canobolas	10712
NSW Rural Fire Service	315055	148.5875	500	Clarke Trig	10562
NSW Rural Fire Service	658353	148.5875	165	Mt Macquarie	9004467
Orange City Council	1082254	148.8625	100	Mt Canobolas	10712
NSW Government	134958	148.9875	83	Blayney	10645
NSW Government	134964	148.9875	83	Fire Station Orange	10693
Integrated Agricultural Developments Pty Ltd	190521	450.125	8.4	Cargo Rd Orange	202797
Cadia Holdings	351021	450.275	8.4	Ridgway Mine	9008502
Orange City Council	1082256	461.04375	25	Mt Canobolas	10712
Orange City Council	229756	461.06875	40	Water Plant Orange	10729
Orange City Council	243158	461.10625	8.4	Water Plant Orange	10729
Blayney Shire Council	654712	461.16875	21	Optus Blayney	201534
Essential Energy	177264	461.225	8.4	Mt Canobolas	10712
Central Tablelands County Council	371633	461.30625	8.4	Mt Canobolas	10712
Orange Ex-Services' Club	1905583	461.4875	17	Forest Rd Orange	10008434
Water NSW	1696606	461.525	33	Mt Macquarie	10652
Essential Energy	169421	461.575	8.4	Mt Canobolas	10712
Orange City Council	1082262	461.64375	12.5	Mt Canobolas	10712
Essential Energy	238883	461.75	17	Mt Canobolas	55757
Water NSW	1696611	461.825	33	Mt Canobolas	10712
Essential Energy	169422	461.9	8.4	Mt Canobolas	10712
Cadia Holdings	163711	471.225	8.4	Cadia Mine	402256
Orange City Council	1600485	503.81875	16	Mt Canobolas	10712
Orange City Council	1103113	504.98125	33	Water Plant Orange	10729
TT And CI Reece	222673	519.825	17	Mt Canobolas	55757
Vertical Telecoms	1181225	3610	12	Mt Canobolas	10708

Client Name	System	MHz	W	Site Name	Site Id
Vertical Telecoms	1038992	3625	12	Mt Canobolas	10708

Table 4-11 Point to Multipoint Services

None of these services should be affected by the wind farm development, with the exception of some areas very close to the turbines where there may be local disturbance due to multipath effects. This is similar to the interference experienced when listening to FM radio on a car radio. There are some locations where various reflected signals combine with the wanted signal to make the FM radio reception very noisy. Moving a fraction of a wavelength (less than a metre at these frequencies) is usually sufficient to change the combination of signals and restore normal reception.

Potential impact of Modification 4

Outside the immediate vicinity of the turbines Modification 4 will have no greater impact on point to multipoint reception than the approved project. In the immediate vicinity of the turbines there may be some minor increase in interference. This is not considered to be a significant impact.

Mobile Radio & Cellular

5. MOBILE RADIO & CELLULAR

5.1 MOBILE RADIO AND CELLULAR PLANNING

Mobile radio and cellular telephone systems have defined base station locations and then defined areas of coverage. CB radio repeater stations are provided to assist users of CB radio by extending the range of communication, which would otherwise be limited by the line of sight between users. There is no guarantee of performance or coverage for CB radio.

The performance of the communication systems within their coverage areas is defined statistically, in a similar manner to that of broadcast systems. There is no guarantee of coverage at any particular location but there is a guarantee that there will not be intolerable interference from other sources at any location within the coverage area.

5.2 MOBILE RADIO

Land mobile radio services (two-way radio) are usually designed to cover as wide an area as possible, within the limits of the licensing conditions. The wind farm is not expected to have any significant impact on the identified services. There may be some impact when a mobile unit is very close to a turbine, depending on the orientation of the turbine, the base station and the user. This can be overcome in the normal manner by moving a short distance.

Figure 5-1 Land mobile base station sites within 25 km radius of the wind farm

The closest land mobile services to the wind farm are at the Cadia mine and associated areas. The mobile services covering the general area around the wind farm are at Mt Canobolas and Mt Macquarie. There are 140 services within the area shown, approximately 25 km radius from the wind farm.

Potential impact of Modification 4

Modification 4 will have essentially the same impact as that of the approved project.

5.3 CB RADIO REPEATERS

There are no CB radio repeaters within 25 km of the wind farm.

5.4 SPECTRUM LICENCES

Mobile telephone (cellular services) are licenced to use a specific part of the radio frequency spectrum. The coverage of the mobile services is determined by the operator and may change in response to demand at any time.

The locations of licenced spectrum sites within 15 km of the wind farm are shown in the following figures.

Figure 5-2 Spectrum Licence Sites – 700 MHz and 800 MHz

700 MHz and 800 MHz spectrum is used for mobile telephone services, with the licences all held by Telstra and Optus.

Figure 5-3 Spectrum Licence Sites – 1800 MHz

The 2.3 GHz spectrum licences in the area are all held by the NBN.

Figure 5-4 Spectrum Licence Sites – 2300 MHz

5.5 SUMMARY

Overall mobile radio is unlikely to be affected by the wind farm. There may be some interference within the wind farm lease area, when people are close to the turbines but this will be localised and only affect those directly associated with the wind farm.

Cellular telephone coverage and performance is not expected to be affected by the wind farm. The nature of cellular services is to have a number of base stations covering any particular area, with the mobile unit selecting the base station with best performance. As the number of base stations increases the likelihood of interference will decrease. The planners of cellular services are aware of the wind farm and will design their services and links to avoid interference.

Potential impact of Modification 4

Modification 4 will have essentially the same impact as the approved project.

Radar, Aviation & Defence

6. RADAR, AVIATION & DEFENCE

6.1 AVIATION SERVICES

There are fixed receiving antennas for aviation services at Mt Canobolas (1.09 GHz) and for Orange airport (125.1 MHz). Neither service should be affected by the wind farm.

The wind farm should have no effect on the aeronautical assigned systems shown in Table 6-1.

Client name	System	MHz	Watts	Site name	Site ID
Airservices Australia	77304	135.25	50	Mt Canobolas	10678
Airservices Australia	77306	133.05	100	Mt Canobolas	10678
Airservices Australia	77303	118.5	50	Mt Canobolas	10678
Airservices Australia	77305	122.75	50	Mt Canobolas	10678
Airservices Australia	1786833	127.7	50	Mt Canobolas	10678
Orange City Council	242679	128.8	4	Orange Airport	204422
Orange City Council	176839	119	2.5	Orange Airport	202195
Central West Helicopters	1843258	120.45	6	Mitchell Hwy Orange	9019485
Central West Helicopters	2137225	128.475	9	Mitchell Hwy Orange	10010183
Regional Express	265900	135.55	7	Orange Airport	204422

Table 6-1 Aeronautical Assigned Systems

Potential impact of Modification 4

The potential impact of Modification 4 is the same as that of the approved project. None of the services should be affected.

6.2 RADIODETERMINATION (RADAR) SERVICES

The wind farm turbines are not within the coverage area of any aviation radar services.

6.3 DEFENCE SERVICES

The public ACMA database does not list any defence radio links in the vicinity of the wind farm. This does not guarantee that there are no defence or security links in the area. There is insufficient information to determine the effect either of the approved project or of Modification 4.

The Department of Defence has been notified of the project and is being consulted as a part of the updated Aviation Impact Assessment.

Emissions from Turbines & Power Lines

7. EMISSIONS FROM TURBINES & POWER LINES

7.1 EMISSIONS FROM TURBINES

The radio communications legislation limits the electromagnetic radiation from wind farm turbines, along with every other electric component of a wind farm. The emissions are limited by the Radiocommunications (Electromagnetic Compatibility) Standard.

The manufacturer of the turbines and other equipment is required to demonstrate compliance with the Electromagnetic Compatibility Standard and to affix a compliance mark to the equipment.

7.2 EMISSIONS FROM POWER LINES

The power transmission lines will be constructed in accordance with the standards and requirements of the state power network operators. There is a requirement to ensure that people and animals are not exposed to hazards due to potential gradients in the earth both under normal operating conditions and under fault conditions. Protection against these hazards is standard engineering practice for power installations.

There is currently no Australian Standard regulating extremely low frequency (power line) electromagnetic fields exposure. The international guidelines developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) [4] are generally accepted as best practice and the power line installation should comply with these guidelines.

The potential for interference with radio and television systems is addressed by Australian Standard AS/NZS 2344 [5]. The power installation should be constructed in accordance with this standard.

Conclusions

8. CONCLUSIONS

This assessment has considered the Flyers Creek Wind Farm proposal in Modification 4 and provides an update to the original telecommunications assessment. The changes contemplated in Modification 4 include a 132 kV power transmission line and an increase in the maximum turbine envelope. The turbine positions remain unchanged from the approved locations.

The increased turbine envelope is not expected to have any material effect on television reception. The geometrical relationship of the television transmitter, the television receiver and the reflecting object (turbine) determine whether interference can occur. As there has been no change in the location of the turbines, the reflection mechanisms are unchanged and the potentially affected area remains the same. The amplitude of reflected signals will increase slightly due to the increased reflecting area.

The 132 kV power transmission line proposed in Modification 4 will not affect television reception.

A pre-construction assessment of the existing quality of the television, radio and telephone/internet transmission will be performed at a representative sample of receivers located within five kilometres of any wind turbine, as required by Project Approval condition G3.

As outlined in Project Approval Condition D14, the operators of the various communication services that may be affected should be advised that the wind farm is to be constructed. The parties identified from the ACMA licensing database are:

- NBN (which was not in existence at the time of the previous assessment)
- Telstra
- Optus
- Commercial and national television broadcasters,
- Air Services Australia
- Rural Fire Service
- Department of Defence
- NSW Government Telecommunications Authority
- State Emergency Service
- Orange City Council
- Blayney Shire Council
- Essential Energy
- Central Tablelands County Council
- Water NSW
- Essential Energy
- Cadia Holdings
- TT And CI Reece
- Vertical Telecoms.

The communication links operated by these licensees have been reviewed in this analysis. With the exception of Paths E and F Modification 4 has no impact on the operation of the communication links.

The increased maximum turbine envelope will require micro-siting of Turbines 21, 23 and 35 to maintain clearance on Path E. For Path F, the location of Turbine 34 should be reviewed as the calculated clearance is within the error of topographic map data and antenna location data. The location of Turbine 35 should be adjusted to provide adequate clearance for Path F. These changes can be made within the micro-siting tolerances of the approved project and is not considered a significant impact.

The telecommunications impacts of the project, as modified by Modification 4, will continue to be managed under the conditions of the Project Approval as summarised in section 1.2.2. These conditions remain appropriate to manage telecommunications impacts resulting from Modification 4

References

9. REFERENCES

[1] *Flyers Creek Wind Farm - investigation of possible impacts on broadcasting and radiocommunication services.* 22nd December 2010 L. J. Derrick, Lawrence Derrick & Associates. Appendix H to the Flyers Creek Wind Farm Environmental Assessment.

[2] *Best Practice Guidelines for Implementation of Wind Energy Projects in Australia.* Clean Energy Council. Available from cleanenergycouncil.org.au

[3] *Technical Information and Coordination Process Between Wind Turbines and Radiocommunication and Radar Systems*, published by the Radio Advisory Board of Canada (RABC) & Canadian Wind Energy Association (CanWEA), 2007

[4] *ICNIRP Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz).* Published in Health Physics 99(6): 818-836; 2010 http://www.icnirp.org/cms/upload/publications/ICNIRPLFgdl.pdf

[5] AS/NZS 2344:1997 (Incorporating Amendment No1). *Limits of electromagnetic interference from overhead a.c. powerlines and high voltage equipment installations in the frequency range 0.15 to 1000 MHz.*

11. CONCLUSIONS

The results of this study are summarised as follows:

- The proposed increase in the maximum turbine envelope proposed as part of Modification 4 does not increase the potential impact to aviation from that previously assessed for the Project.

11.1. Regulatory requirements

- There is no regulatory requirement for lighting of obstacles lower than 150 m AGL (492 ft) and that are not within the vicinity of an aerodrome.
- With respect to MOS 139 7.1.5.1, the proposed wind turbines and WMTs must be reported to CASA if they will be higher than 110 m AGL.
- With respect to MOS 139 7.1.5.2, the wind turbines or WMTs must be regarded as an obstacle if they are higher than 150 m AGL, unless CASA assesses otherwise. Obstacle monitoring includes the PANS OPS surface which extends beyond the OLS of the aerodrome.
- With respect to MOS 139 9.4.1.2 (b), the wind turbines or WMTs will need to be lit if they will be outside the OLS and above 110 m AGL, unless an aeronautical study assesses they are of no operational significance.
- **Aviation Projects assesses that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a wind turbine, without obstacle lighting on the turbines of the Project**. Section 10– Risk Assessment of the aeronautical impact assessment concluded no lights were not required for wind turbines or wind monitoring towers.

11.2. Consultation

- The following parties were consulted about the proposed planning modification:
    - Aerial Agricultural Association of Australia;
    - Airservices Australia;
    - Department of Defence;
    - Fred Fahey Aerial Services; and
    - Orange City Council.

11.3. Aviation Impact Statement

- Based on the proposed FCWF layout and overall WTG overall blade tip height limit of 160 m AGL, the blade tip elevation of the highest WTG, which is WTG20, will not exceed 1114 m AHD (3655 ft AMSL) and:
    - will not penetrate any OLS surfaces;
    - will not penetrate PANS-OPS surfaces;

- will not have an impact on nearby designated air route or grid lowest safe altitudes;
- will not have an impact on prescribed airspace;
- is contained within Class G airspace; and
- is outside the clearance zones associated with aviation navigation aids and communication facilities.

- With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 1114m (3655ft) AHD the wind farm will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Orange, Cowra or Bathurst Airport, any air route lowest safe altitude (LSALT) and will not adversely impact the performance of Precision/Non-Precision Nav Aids, HF/VHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.

11.4. Aircraft operator characteristics

- Aircraft will be required to navigate around the Project site in low cloud conditions where aircraft need to fly at 500 ft AGL.
- Although there is no requirement to do so, the Proponent may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for their safe operation within the Project area.
- Wind turbines are generally not a safety concern to aerial agricultural operators. Wind monitoring towers remain the primary safety concern to aerial agricultural operators, who have expressed a general desire for these towers to be more visible.
- Air operators: There is a relatively low rate of aircraft activity in the vicinity of the wind farm site.
- Aerial fire fighting: There are no known aerial agriculture operations conducted at night in the vicinity of the wind farm site. Any fire-fighting activities in the vicinity of the proposed wind farm by either fixed or rotary wing aircraft would need to be conducted in consideration of the location of the wind turbines and monitoring masts. To this end it is important that the location of the wind turbines and monitoring masts are made available to fire-fighting agencies and aerial agriculture operators.

  Notwithstanding that aerial fire-fighting operations will potentially be restricted in the vicinity of the proposed wind farm, there is still a valid (ground-based) means of fighting bushfires on and near the properties on which the wind farm is proposed to be located.

  The Country Fire Authority Emergency Management Guidelines for Wind Energy Facilities includes a section on planning, design and development of wind energy facilities and section 2(2.3) stated:

  > *Wind turbines should be located approximately 300 metres apart. This provides adequate distance for aircraft to operate around a Wind Energy Facility given the appropriate weather and terrain conditions. Fire suppression aircraft operate under "Visual Flight Rules". As such, fire suppression aircraft only operate in areas where there is no smoke and during daylight hours. Wind turbines, similar to high voltage transmission lines, are part of the landscape and would be considered in the incident action plan.*

- Aerial agricultural operators: The proposed wind farm will most likely prevent fixed wing aerial agricultural operations on the wind farm site, whilst the viability of conducting these operations on properties adjacent to the wind farm would have to be assessed on an individual basis.

  It is reasonable to conclude that safe aerial application operations would be possible on properties neighbouring the proposed wind farm with some operational or cost impacts, subject to final microsited turbine locations, and subject to a case by case assessment.

  The use of helicopters enables aerial application operations to be conducted in closer proximity to obstacles than would be possible with fixed wing aircraft due to their greater manoeuvrability.

11.5. Hazard lighting and marking

- With respect to MOS 139 7.1.5.1, the proposed wind turbines must be reported to CASA if they will be higher 110 m AGL. With respect to MOS 139 7.1.5.2, the proposed 160 m wind turbine overall blade tip height must be regarded as obstacles since they are higher than 150 m AGL.
- There are two existing WMTs at a height of 82 m (269 ft), which have been reported to Airservices Australia.
- With respect to MOS 139 9.4.1.2 (b), the wind turbines and WMTs will need to be lit if they are higher than 110 m AGL, unless an aeronautical study assesses they are of no operational significance.
- CASA has advised that it will only review assessments referred to it by a planning authority or agency.
- **Aviation Projects assesses that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a wind turbine, without obstacle lighting on the turbines of the Project.**
- If obstacle lighting is required by the assessment manager, installed lights should be designed according to criteria set out in the applicable regulatory material.
- With respect to marking of turbines, a white colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.
- Consultation with Department of Defence regarding lighting has been undertaken during the preparation of the aviation impact assessment. Department of Defence has reviewed the requirement for lighting and has determined that lighting will not be required. If LED lighting is proposed, Department of Defence requests that the frequency range of the LED light emitted should be within the range of wavelengths 665 to 930 nanometers, so that the WTGs are visible to pilots using night vision goggles.

  If wind monitoring towers are constructed as part of the proposal, Defence notes that the National Airports Safeguarding Framework Guideline D – Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers - Paragraph 39 recommends the top 1/3 of wind monitoring towers are painted in alternating contrasting bands of colour in accordance with the Manual of Standards for Part 139 of the Civil Aviation Safety Regulations 1998.
- Although there is no obligation to do so, consideration should be given to marking any wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings (as modified by the guidance in NASF Guideline D).

- With respect to power line route determination (refer to Section 4.3), it is prudent to consider potential adverse impacts on aerial application operations. Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial agriculture operators and marked in accordance with MOS 139 Section 8.10 Obstacle Markings; specifically:

  > *8.10.2.8 Wires or cable obstacles must be marked using three-dimensional coloured objects such as spheres and pyramids, etc; of a size equivalent to a cube with 600 mm sides, spaced 30 m apart.*

- The transmission line and switching station proposed as part of Modification 4 will not adversely affect aircraft operations.

11.6. Risk assessment

A summary of the level of risk associated with the Project under the proposed treatment regime, with specific consideration of the effect of obstacle lighting, is provided in Table 11 of Section 10.

11.7. Conditions of approval

- Conditions of approval D11, D12, D13, D22 and D25 were identified as being relevant to the assessment contained herein.
- In relation to Condition D11 (a), correspondence sent from Orange City Council to FCWFPL advised that there would be no impact on current or future obstacle limitation surfaces of Orange Airport.
- In relation to Condition D11 (b), redesign of the NDB approach at Orange Airport is not required, since the NDB has been decommissioned, and Airservices Australia has advised that there will be no impacts on instrument approach procedures at aerodromes, navigational aids, communications and surveillance facilities.
- In relation to Condition D12, during recent consultation, RAAF AIS advised that all future correspondence should be directed through Airservices Australia. Accordingly, the requirement to notify Royal Australian Air Force – Aeronautical Information Services should be removed from this condition.
- The remainder of Conditions D11, D12, D13, D22 and D25 remain appropriate to managing potential aviation impacts.

12. RECOMMENDATIONS

If the recommendations set out below are implemented, the Project will not adversely affect the safety, operational integrity and efficiency of air services.

Notification and reporting

1. 'As constructed' details of wind turbine and WMT coordinates and elevations should be provided to Airservices Australia, using the following email address: vod@airservicesaustralia.com.

2. Any obstacles above 110 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:

    a. The planned operational timeframe and maximum height of the crane; and

    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.

3. Details of the wind farm should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the wind farm on their operations. Specifically, details should be provided to the NSW/ACT Regional Airspace and Procedures Advisory Committee for consideration by its members in relation to VFR transit routes in the vicinity of the wind farm.

Operation

4. Although not a mandatory requirement, the Proponent should consider engaging with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project.

Marking of turbines

5. The rotor blades, nacelle and the supporting mast of the wind turbines should be painted a white colour, typical of most wind turbines operational in Australia.

Lighting of turbines

6. **Aviation Projects has assessed that the Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft.**

7. If obstacle lighting was required by the assessment manager, the lighting should have the following characteristics:

    a. Obstacle lighting should be designed in accordance with the characteristics specified in ICAO Annex 14 Vol 1 Chapter 6 (note that Section 6.2.4 addresses obstacle marking and lighting of wind turbines) and MOS 139 Chapter 9 (note that Section 9.4.3.4A addresses obstacle lighting for a wind farm), while minimising visual impact;

    b. Department of Defence determined that lighting will not be required. If LED lighting is proposed, the frequency range of the LED light emitted should be within the range of wavelengths 665 to 930 nanometres for night vision devices compatibility; and

c. To ensure the ongoing operation and availability of obstacle lights (if required) at night and during times of reduced visibility, a monitoring, reporting and maintenance program should be established in accordance with the guidance in MOS 139 Section 9.4.10.

8. Any decision to require or to nor require lighting remains with the planning authority to determine.

Marking of wind monitoring towers

9. Consideration should be given to marking any new WMTs according to the requirements set out in MOS 139 Section 8.10 (as modified by the guidance in NASF Guideline D).

Marking of overhead transmission lines and poles

10. Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial agriculture operators and marked in accordance with MOS 139 Section 8.10.2.8.

Micrositing

11. Alteration to the siting of a turbine or WMTs will not be more than 100 m and micrositing will address any consequential changes to access tracks and internal power cable routes. The potential micrositing of the turbines has been taken into account in the assessment with the estimate of the overall maximum height being based on the highest ground level within 100 m of the nominal turbine position. The micrositing of the turbines is not likely to result in a change in the maximum overall AGL blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this aviation impact assessment would remain the same.

ANNEXURE 1 – WIND TURBINE COORDINATES AND APPROXIMATE HEIGHTS

A1.1 Wind turbine generator centre point coordinates and approximate heights

Note, the turbine positions have not changed from the approved locations (Project Approval, November 2017).

WTG ID	*Easting (m)*	*Northing (m)*	*Base Elevation (m AHD)*	*Tip Height for WTG (m AGL)*	*Tip Height for WTG (m AHD)*
WTG3	692487	6290959	896	160	1056
WTG5	692610	6290375	900	160	1060
WTG6	692438	6289879	867	160	1027
WTG7	692375	6289621	856	160	1016
WTG8	691922	6289293	869	160	1029
WTG9	691710	6288716	855	160	1015
WTG10	690463	6289008	826	160	986
WTG11	690764	6288686	833	160	993
WTG15	694616	6287092	899	160	1059
WTG18	693315	6284663	919	160	1079
WTG19	693106	6284262	922	160	1082
WTG20	693633	6283962	954	160	1114
WTG21	691091	6283878	856	160	1016
WTG22	691440	6283635	876	160	1036
WTG23	691436	6283205	863	160	1023
WTG24	690258	6283778	822	160	982
WTG25	690357	6283178	860	160	1020
WTG26	690381	6282714	840	160	1000
WTG27	689933	6282625	841	160	1001
WTG28	689635	6282686	819	160	979
WTG29	689403	6282413	792	160	952
WTG30	689820	6282149	817	160	977
WTG31	690231	6282050	835	160	995
WTG32	692382	6282353	878	160	1038

WTG33	692173	6281920	915	160	1075
WTG34	692320	6281639	901	160	1061
WTG35	692379	6281358	894	160	1054
WTG36	692852	6280328	884	160	1044
WTG37	692897	6279893	826	160	986
WTG38	694007	6282678	881	160	1041
WTG39	695178	6283099	922	160	1082
WTG40	695285	6282880	919	160	1079
WTG41	695383	6282655	911	160	1071
WTG42	695229	6282331	898	160	1058
WTG43	696494	6283966	943	160	1103
WTG44	696745	6283761	922	160	1082
WTG45	696940	6283488	902	160	1062
WTG46	697221	6283308	882	160	1042

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aviationprojects.com.au